A QUARTERLY MACROECONOMETRIC MODEL OF THE HONG KONG ECONOMY

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ABSTRACT

Macroeconometric models have been developed well in those developed nations. They serve for three main purposes: structural analysis, forecasting and policy evaluation. These enhance our understanding to the functioning of the economy and help the plannings of administration authorities as well as people at large. In Hong Kong there are so far only two such model being published and both of them using annual data for the estimation. However if the observations can be defined on a shorter period of time, the most current information can be incorporated into the model so that quality of forecasts made will be better. Moreover the specification, if there was any, may be reduced to a less extent. A quarterly macroeconometric model, which consists of 18 equations in five sectors, is thus developed.

After a detailed discussion of the theoretical basis of the model, three-stage least squares regression method is employed in the estimation process for its gain in efficiencies of the estimated parameters. Structural analysis, forecasting and policy evaluation are performed. The results reveal that the import leakage is large which resulted in a less powerful fiscal policy of the government. The simple balanced budget multiplier does not hold in the economy, which suggests the existence of 'crowding out' effect.

The highly trade-oriented characteristic of the economy is also revealed in the model. Through merchandises trading activities,

external disturbances originated from other nations get transmitted to the economy, which affect the performance in a great extent especially on the price level of the economy.

The forecasts made for quarters in 1982 shown that performance of the economy in this period depends heavily on the recovery of the United States economy. If the recovery starts at the second half of the year 1982, a double-digit growth rate of gross domestic product can be retained; otherwise the rate will drop to only 6 per cent by the end of the year 1982. The inflation rate of the economy, which is measured by the rate of change of consumer price index (A), will be curbed to 11 per cent by the end of the year in view of the relatively stable prices of crude oil and raw materials throughout the year 1982.

Finally it is noted that the system is not capable of generating cyclical fluctuations which means that the lagged responses of endogenous variables to the changes on exogenous variables diminish gradually over time.

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CHAPTER I

INTRODUCTION

1.1 Objective of the Study

'Quantification' is a necessary, though not sufficient, condition for the precision of a subject. In studying macroeconomics, it is common to see cases where conclusions in a large degree depend on the numerical values which various parameters actually take. For instance, the effectiveness of the monetary policy depends heavily on the interest elasticity of the demand for money. If sufficient data are available, these parameters can be estimated with regression methods. Macroeconometric models, which are sets of logical stochastic relations between aggregate economic variables with estimated parameters, can then be set up to depict the interactions among these variables as well as the simultaneity nature of the system quantitatively. With these macroeconometric models, the structure and the dynamic behaviour of the economy can be investigated on a more concrete basis. Furthermore the models can provide forecasts for future changes in the economy as a guide to the policy actions of government and plannings of people at large.

For the case of Hong Kong, there are so far only two macroeconometric models being published,[1] and both of them use annual data for the estimation. However if there are enough data, it will be better to have the observations of variables defined on a shorter period of time. The reasons are: (i) it is impossible to see inter-

actions between variables at any instant of time; there will only be uni-directional effect between the variables in the immediate run. It is the aggregation of time for the opposite direction effect be possible. Thus the specification error of equations, if there is any, can be reduced to a less extent in a quarterly model than in an annual one, (ii) the most current information of the system can be incorporated into a quarterly macroeconometric model so that the quality of the forecasts made may be better. Thus the present study tries to set up a quarterly macroeconometric model for the Hong Kong economy.

1.2 Data Sources and Its Limitation

The Census and Statistics Department of the Hong Kong Government expands rapidly in recent years. It supplies official statistics of the economy in its regular publications such as Monthly Digest of Statistics, Economic Background and Estimates of Gross Domestic Product. These publications are the major data sources of the present study. Survey statistics which require much manpower and expenses are not officially available and are compiled by methods of interpolations and disaggregation of annual data into quarterly ones.[2] For instance the nominal wage rate index of workers in manufacturing industry is available only in the first and third quarter of a year. The remaining two quarterly figures are obtained by interpolations under the assumption of constant growth rate during the half-year time span. Notes will be given whenever these methods are used in this study.

1.3 Methodology and The Plan of Study

The quarterly model built in the present study is a demand-side macroeconometric model derives mainly from Keynesian economics. This implies the assumption of perfect elasticity in the supply of commodities and services. This may remain doubtful in the real world, however the validity of the model is tested on its ability to replicate the historical data of variables as well as its forecasting power to future changes of these variables.[3]

As to the plan of study, it starts with the brief descriptions of macroeconometric model and its uses which can enhance our understanding of the present study. In addition, a review on the economic background in the seventies, which enables us to be more familiar with the system we are going to study, and on some notable work done before on this topic may give us some idea in the formulation of the present model. All these are presented in chapter II.

In chapter III, we apply our theoretical consideration of the economy to set up the quarterly macroeconometric model and obtain empirical results using three-stage least squares method. There will be five sectors in the model: consumption and investment sectors explain the variations in private consumption expenditure and the gross domestic fixed capital formation of private sector; trade sector consists of equations on exports and imports of goods and services; price sector composes of equations explaining prices of domestic exports and general price level indicated by consumer price index and gross domestic product deflator; and finally the savings deposits, time deposits, demand deposits and currency in circulation describe the money sector of the model. There will be

discussions on the specifications of each equation in these sectors. After a brief review on the estimation technique of the model, the empirically estimated model based on 29 observations dating from the fourth quarter of 1973 to the fourth quarter of 1980 is presented. Implications to the functioning of the economy by this estimated quarterly model will be investigated through structural analysis.

Simulation, which is used to test the model's ability in replicating historical data, is performed on chapter IV to evaluate the estimated model. Root-mean-square error and root-mean-square percent error will be calculated to measure quantitatively the deviations of the estimated model from the real world. Then ex ante forecasts for 1981 and 1982 will be made. There will be pessimistic as well as optimistic forecasts for quarters in 1982 to account for the alternative economic situations of the United States in this year.

After evaluating the model and making forecasts, policy implications and impacts of external disturbances on the economy will be discussed on chapter V through multiplier analysis. Reduced and final forms of the model will be derived based on the estimated structural equations of chapter III to gain this end.

Finally chapter VI gives a summary on the present study and some remarks for future work will conclude the thesis.

FOOTNOTES FOR CHAPTER I

1. The two models are by T.B. Lin, "The ERC Forecasting Model of the Hong Kong Economy,' Southeast Asian Studies, Vol. 17, No. 2, September 1979, pp. 273-90, and by T.T. Hsueh & K.K. Chow, 'A Dynamic Macroeconomic Model for the Hong Kong Economy,' Hong Kong Economic Papers, 1981, forthcoming.
2. For a thorough discussion for the appropriateness of using unreal assumptions, see M. Friedman, 'The Methodology of Positive Economics,' in Essays in Positive Economics, University of Chicago Press, 1935, pp. 3-43.
3. M. Friedman, 'The Interpolation of Time Series by Related Series,' American Statistical Association Journal, December 1965, pp. 729-57, and also J.H.C. Lisman & J. Sandee, 'Derivation of Quarterly Figures from Annual Data,' Applied Statistics, Vol. 13, 1965, pp. 85-90.

CHAPTER II

GENERAL DESCRIPTION OF MACROECONOMETRIC MODEL AND THE ECONOMIC BACKGROUND OF HONG KONG IN THE SEVENTIES

2.1 Macroeconometric Modelling and its Uses

Economic theory has long been treated in two unlike parts which are known as microeconomics and macroeconomics. The former deals with the behaviour of individuals in different market structures while the latter concerns broad economic relationships. In this study, interest is to investigate the interdependency of such economic variables as total consumption, total investment, exports, imports and many other aggregates of an economy and thus the study is at macro level. To serve this aspect of study, macroeconometric models are often constructed to enhance systematic formulation of hypotheses on the functioning of an actual economic system. These models represent economic system by a set of logical and stochastic relations among aggregate economic variables and the simultaneity nature of a system is captured by the interdependency of these relations.

In a macroeconometric model variables are divided into two categories. Endogenous variable is one whose behaviour is explained within the system under investigation and those not locally determined are called exogenous variables. Each endogenous variable is explained by one relation in the model and intrinsically the number of endogenous variables should be equal to the number of relations stated. This characteristic is known as the 'completeness' of the model.

The relations in a macroeconometric model are also classified into four types. The behavioural relations show how a variable responds to the stimulus encountered. Identities are definitional relations between variables which are not falsified by any change of other conditions. Technical relations such as production function of an economy appear to be another type. By specifying the amount of factors input, the total value of output is automatically fixed by the current technological level, thus no evaluation process is necessary during their formulations. Finally equilibrium relations are sometimes explicitly stated.

Macroeconometric modelling is similar to the formulation of a macroeconomic model but distinguishing by a significant feature. Macroeconomic models treat economic relations from a deterministic point of view. For instance, by specifying the functional form of the relation between aggregate consumption and its related factors, the consumption expenditure of the economy can be determined without error. Macroeconometric models differ in that a stochastic variable, known as the disturbance, is added to each relation of an algebraic macroeconomic model[1] except identities and equilibrium relations. The inclusion of this disturbance term can be justified in several aspects. First the requisition of abstraction suggests that major affective factors are selected and hence a stochastic disturbance term is needed to account for the joint effect of those 'seemingly irrevelant' factors. Second even though this joint effect may be negligible, measurement errors on those aggregates discards the deterministic approach to explore the relationship between these variables. However the most eminent argument remains that though we are searching for regularities out of chaos, randomness in the behaviour of human beings must also be appreciated at the meanwhile.

The stochastic nature of the disturbance term plays an important role in macroeconometric models. It introduces a chance mechanism in which the likeliness of occurrence of different values of endogenous variables depends on the probability distribution of this disturbance term. By assuming the relationships are linear in parameters, different techniques of estimation are used to obtain the parameters of these relations. Hypotheses on these relations can then be tested explicitly and this may lead to the modification of the macroeconometric model, both in its specifications of variables as well as the functional form of relations. This process is sometimes repeated several times in the construction of the model until satisfactory results are obtained. Thus a macroeconometric model interweaves economic theory, statistical knowledge as well as one's judgement of facts. Its formulation is an art rather than a monotonous or mechanical work.

Macroeconometric models flourish in developed countries such as United States, Japan and Western Europe countries.[2] They are of many uses which can be classified as structural analysis, forecasting and policy evaluation. Structural analysis is the investigation of relations in the model so that phenomena can be understood more thoroughly. This is done through the interpretation of the estimated parameters. Manipulation of these parameters can give us the immediate and dynamic effects on the endogenous variables inducing by changes of exogenous ones. This is known as multiplier analysis of a macroeconometric model. Other structural parameters of the system such as elasticities and comparative statics results can also be obtained from these estimated parameters. Furthermore conflicting or rival theories in viewing the structure of an economy can be explicitly tested and arguments be settled.

Forecasting is the second main use for a macroeconometric model. Men often try to predict their future or the future behaviour of something in which they are interested. Since economic factors affect our quality of life in a great extent, it is natural for people to make forecasts on economic variables. Macroeconometric models have been employed to predict the future performance of an economy reflecting in the value of aggregate variables since 1950s.[3] In the past, forecasts are often made under some 'expert' opinion or by the method of extrapolations. The former is subject to personal judgement which will be biased and difficult to follow, while the latter has its drawback in the missing of the simultaneity nature of the economy. On the contrary, a good macroeconometric model persuades people in a systematic way just like other branches of science: its line of thought running from the underlying assumptions to the finally accepted opinions is clearly expounded. One can trace the reasoning so that suggestions or conflicting views can be raised in a more concrete way.

Policy evaluation is another prominent use of macroeconometric models. In fact it links with the forecasts made by the model. Whenever future behaviour of an economy has to be predicted, it must be based on the assumption of actions by the administration authority. On the other hand, these actions are also based on the forecasts made by the model. There will be feedback effects to each other. Competing policies exist and it is the duty of a macroeconometric model to help policy makers to select the optimal one.

As a conclusion, a macroeconometric model will do much good to our understanding in the functioning of an economy. It is also useful for the policy makers in national or regional macroeconomic planning, through which betterment in quality of human's life will be speedily realized.

2.2 The Economic Background of Hong Kong in the Seventies

Hong Kong is mainly composed of Hong Kong Island and Kowloon Peninsula with total area amounted to 1,046 square kilometres.[4] Entrepot trading was the major source of foreign exchange for the colony until the early 1950s. The imposition of the Embargo on trade with the People's Republic of China by the United Nations pushed Hong Kong onto the road of industrialization. With their hard working efforts and intelligence, the people of Hong Kong have marked this path a charming one which is often praised the miraculous economic development. Table 2.1 shows the total and per capita gross domestic product during the period 1966 to 1980. Though it has been argued in their imperfections as indices of economic development, it will not be far from reality that the standard of living of people in Hong Kong has been improved very much during the time span stated. Both measures have been doubled within a decade in the seventies.

Hong Kong is not blessed with abundant natural resources. What attributes to its development can be reviewed from a brief look of the components of the gross domestic product. Table 2.2 exhibits these components which include the private consumption expenditure, government consumption expenditure, gross domestic fixed capital formation, total exports and imports of goods, as well as the net exports of services within the decade 1970. There we see that both the merchandises exports as well as the total domestic demand, which includes private consumption expenditure, government consumption expenditure, gross domestic fixed capital formation and increase in stocks, contributed significantly to the growth of the economy during this period. Both of them have been trebled within this decade in real terms. Though the oil crisis in the early 1970s exerted a great pressure to a downward fall in the exports of goods as the major markets such as the United States, United Kingdom and West Germany suffered from a serious recession, the economy has

TABLE 2.1

GROSS DOMESTIC PRODUCT AND PER CAPITA
GDP OF HONG KONG, 1966-80

Year	GDP at Constant 1973 Market Prices	Annual Growth Rate of GDP	GDP Per Capita at Constant 1973 Market Prices	Annual Growth Rate of Per Capita GDP
1966	18,411($mn.)		5,071($)	
1967	19,837	7.75(%)	5,329	5.09(%)
1968	20,775	4.73	5,463	2.51
1969	23,856	14.83	6,174	13.01
1970	25,344	6.24	6,402	3.69
1971	26,612	5.00	6,578	2.75
1972	29,190	9.69	7,092	7.81
1973	33,796	15.78	8,022	13.11
1974	34,574	2.30	8,004	-0.22
1975	35,349	2.24	8,041	0.46
1876	42,005	18.83	9,452	17.55
1977	46,281	10.18	10,262	8.57
1978	51,052	10.31	11,106	8.22
1979	57,565	12.76	11,799	6.24
1980	63,179	9.75	12,539	6.27

Source: Census and Statistics Department, Estimates of Gross Domestic Product 1966-1980, Hong Kong: Government Printer, 1982, p. 12.

TABLE 2.2 THE SELECTED COMPONENTS OF GROSS DOMESTIC PRODUCT, 1971-1980
(AT CONSTANT 1973 MARKET PRICES)

GDP Components(selected)	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1. Private Consumption Expenditure	19,001	20,188	23,785	23,527	24,005	26,119	30,626	35,984	39,389	44,273
2. Government Consumption Expenditure	1,571	1,707	1,912	2,106	2,213	2,392	2,690	3,033	3,356	3,612
3. Gross Domestic Fixed Capital Formation	5,513	5,788	6,698	6,490	6.578	7,681	9,683	11,287	13,372	15,570
4. Exports of Goods	21,673	23,154	25,999	24,373	25,161	32,215	33,853	38,517	46,030	54,192
5. Imports of Goods	25,355	26,247	29,049	26,068	27,046	33,743	36,424	44,244	51,281	60,832
6. Exports Less Imports of Services	4,209	4,600	4,316	3,677	3,725	4,926	4,522	4,903	4,725	4,407
7. Domestic Demand (= (1) + (2) + (3))	26,085	27,683	32,395	32,123	32,796	36,192	42,999	50,304	56117	63,455

Source: Census and Statistics Department, Estimates of Gross Domestic Product 1966 to 1980, Hong Kong: Government Printer, 1982, p. 12, Table 1(B).

Note: All figures are in million dollars.

recovered faster than expected. There is a continuation of a double digit growth in the gross domestic product in real terms in the late 1970s.

The admired performance in exports was not attained without any hardship encountered. Throughout the 1970s, keen competition from other Asian countries such as Taiwan and South Korea has resulted a shift from the production of traditional labor intensive exports to skill and capital intensive products. More harshful is the restrictions laid down by the foreign countries to protect their local industries or other developing countries which affected Hong Kong in a great adverse extent. For instance the Multi-Fibre Arrangement made in 1974 restrained the growth of the textile industry and results the name 'twilight industry' in recent years. Table 2.3 shows the percentage share of the major industries in domestic exports dating back to earlier years. It can be seen that the textile industry has declined in its importance and electronics industry has emerged to play a more important role in Hong Kong's domestic exports.

Goods cannot be produced out of nothing. Since Hong Kong lacks natural resources, availability of raw materials to the economy is a pre-requisite for production. Moreover imports of foodstuff are significant for an economy of five million people which lacks arable lands. These views are firmly supported by figures in Table 2.4, which shows the imports of the economy classified by their end-uses. The close link between exports and imports of the economy can also be seen from Table 2.2. The synchronous movements in their magnitudes tell the fact that imports to the economy is mainly for production of exports. The growing share of consumer goods in the total imports of the developing economy suggests that income elasticity of imports would be high for this small open economy.

TABLE 2.3

PERCENTAGE SHARE OF MAJOR INDUSTRIES
IN DOMESTIC EXPORTS
(1959-1980)

Year	Clothing	Textile	Plastic	Electronics
1959	34.8	18.1	7.0	.....[a]
1964	36.6	16.0	11.0	2.4
1970	35.1	10.3	11.3	9.5
1971	39.7	10.2	11.0	10.1
1973	38.3	12.1	10.6	12.4
1974	38.2	11.9	9.1	12.0
1975	44.6	9.4	8.7	10.7
1976	43.8	9.4	7.8	11.4
1977	39.7	7.6	9.2	12.7
1978	38.6	6.9	9.1	15.2
1979	36.0	7.1	9.1	16.8
1980	34.1	6.5	8.2	18.5

Source: Census and Statistics Department, Hong Kong Trade Statistics, Hong Kong: Government Printer, various issues.

[a]Complete figures are not available.

TABLE 2.4

PERCENTAGE SHARE OF IMPORTS CLASSIFIED BY END-USE
(1964-1980)

Year	Foodstuff	Consumer Goods	Fuels	Raw Materials	Capital Goods
1964	24.7	19.7	2.8	44.3	8.5
1968	20.7	23.9	3.1	43.8	8.6
1970	17.9	25.5	2.7	41.7	12.2
1972	17.5	25.8	2.8	41.0	12.8
1974	18.4	22.3	5.9	40.9	12.6
1976	16.0	21.4	5.9	44.1	12.6
1978	13.5	26.6	4.7	42.2	12.9
1980	10.8	26.4	6.8	41.6	14.4

Source: Census and Statistic Department, Hong Kong External Trade, Hong Kong: Government Printer, various issues.

Another notable feature of the imports figures is the increase in the relative importance of capital goods. This generates a substantial increase in gross domestic fixed capital formation as can be seen from Table 2.2, where it has a faster pace than the growth of gross domestic product of the economy in the late 1970s. This may attribute to the boom of the economy and that government is pressed, if not induced, to work out a development plan for the society. Part of this plan is realised especially in traffic and housing aspects. The construction of the Mass Transit Railway and the public housing contribute to a significant part as can be seen from Table 2.5.

The increasingly important role of the government in the 1970s is only partly reflected in the above-cited statistics. A more complete view can be seen through the growing in size, both absolutely and relatively, of the public sector in the seventies. In Table 2.6 it can be seen that the relative size of the public sector expands rapidly in recent years which climbed up to a 20 per cent share in 1980.

It is asserted by experience that there will be great inflationary pressure to an economy with rapid growth rate. As for Hong Kong this was not experienced until late 1970s. Table 2.7 laid down the inflation rate, which measured by the rate of change of consumer price index, of the economy during 1966 to 1980. The tremendous high rise of price in 1973 and 1974 was attributed to the sharp rise in crude oil price administered by the O.P.E.C. (Organisation of Petroleum Exporting Countries) which resulted in an extraordinary rise in prices of imports. Furthermore the prices of imports will affect significantly those prices of domestic exports as has been pointed out that the economy lacks natural resources and raw materials used in the production of domestic exports are mainly imported. Table 2.8 shows the synchronous movements of unit value indices of domestic exports and imports.

TABLE 2.5

PUBLIC INVESTMENT IN BUILDING AND CONSTRUCTION
(1970-1980)

Year	Actual Figure [1]	Percentage Share in Total Gross Domestic Fixed Capital Formation
1970	525	11.5
1971	691	12.5
1972	731	12.6
1973	964	14.4
1974	1,273	19.6
1975	1,395	21.2
1976	1,609	20.9
1977	2,283	23.6
1978	2,866	25.4
1979	2,850	21.3
1980	2,819	18.1

Source: Census and Statistics Department, Estimates of Gross Domestic Product 1966-1980, Hong Kong: Government Printer, 1982, pp. 16-17.

[1] Actual figures are in constant 1973 million dollars.

TABLE 2.6

RELATIVE SIZE OF THE PUBLIC SECTOR FOR THE FISCAL YEARS 1971 TO 1980

Fiscal Year	Consolidated Account Expenditure at Current Prices	GDP at Current Prices	Relative Size of the Public Sector
1971	2,952($mn.)	21,873($mn.)	13.6(%)
1972	3,875	25,854	15.0
1973	5,061	33,964	15.0
1974	6,692	38,786	17.3
1975	6,576	40,574	16.2
1976	7,355	51,973	14.2
1977	9,168	59,615	15.4
1978	12,122	69,557	17.4
1979	15,619	89,473	17.5
1980	22,506	111,114	20.3

Source; Hong Kong Government, The 1982-1983 Budget: Speech by the Financial Secretary, moving the Second Reading of the Appropriation Bill, 1982, Hong Kong: Government Printer, 1982, statistical table (1).

TABLE 2.7

INFLATION RATE MEASURED BY RATE OF CHANGE OF CONSUMER PRICE INDEX*
(1966-1980)

Year	General Consumer Price Index	Percentage Change	Consumer Price Index (A)	Percentage Change
1966	104.7	2.65		
1967	111.2	6.21		
1968	114.0	2.52		
1969	118.1	3.60		
1970	126.5	7.11		
1971	130.8	3.40		
1972	138.8	6.12		
1973	164.0	18.16		
1974	187.6	14.39	107.0	11.46
1975	189.8	1.17	107.5	0.47
1976			111.2	3.44
1977			117.7	5.85
1978			124.7	5.95
1979			139.2	11.63
1980			160.8	15.52

Source: Census and Statistics Department, Monthly Digest of Statistics, Hong Kong: Government Printer, various issues.

*The General Consumer Price Index was constructed basing on the spending pattern of households whose monthly expenditure ranged from 100 to 1,999 dollars in a sample survey of consumer expenditure conducted during the period September 1963 to August 1964, thus the index is equal to 100 in this period. It was abolished and substituted by the Consumer Price Index (A) which has its base period at July 1973 to June 1974.

TABLE 2.8

UNIT VALUE INDEX FOR DOMESTIC EXPORTS AND IMPORTS OF GOODS[1] (1971-1980)

Year	Domestic Exports	Rate of Change in Percentage	Imports	Rate of Change in Percentage
1971	80.4		81.6	
1972	84.6	5.22	84.2	3.19
1973	100.0	18.20	100.0	18.76
1974	121.2	21.20	130.9	30.90
1975	117.3	-3.22	123.7	-5.50
1976	128.9	9.89	128.9	4.20
1977	131.8	2.25	134.4	4.27
1978	138.9	5.39	142.8	6.25
1979	163.6	17.93	168.4	17.93
1980	179.8	9.90	184.1	9.32

Source: Census and Statistics Department, Hong Kong Annual Digest of Statistics, Hong Kong: Government Printer, 1981, p. 78.

[1]The base year of the indices are at 1973, i.e., two indices are equal to 100 at 1973.

The brief summary of the Hong Kong economic background in the 1970s above, characterised by the key macro elements of the system, tells the fact that external disturbances, such as recession in its major exports markets and tremendous high rise in imports prices, determine significantly the performance of the economy. As postulated by both classical and neo-classical economists, international trade is the 'engine of growth' of a developing country.[5] This has once again be affirmated by the case of this small open economy. In addition inflationary pressure is experienced partly due to its import-dependent production and rapid economic growth. Both suggest the need for some kind of discretionary policy to stabilize the economy during its growth in the coming decades.

2.3 Summary of Existing Macroeconometric Models of the Hong Kong Economy

Macroeconometric modelling has not been developed in a full extent in Hong Kong. There are so far only two such models published. Both of them use annual data of the two decades 1960s and 1970s but are with different objectives. The smaller one is by Hsueh and Chow[6] which followed closely G.C. Chow's line of thought in its formulation. The objective is to trace the paramount growth paths of the key macro elements of the economy. The model is a system of five equations, of which four are structural and the remaining an identity. For each structural equation there are lagged endogenous variables so that consequently the time paths of the endogenous variables can be deduced and analysed. In addition there are other five exogenous variables and hence a total of nine pre-determined variables in the model. All variables in the model are measured in nominal terms. Table 2.9 and Table 2.10 summarise the model.

TABLE 2.9

VARIABLES OF THE DYNAMIC MODEL, 1961-1979

5 Endogenous Variables		5 Exogenous Variables	
C	: Private Consumption Expenditure	E	: Exports of Goods
I	: Gross Domestic Fixed Capital Formation	G	: Government Consumption Expenditure
M	: Demand for Money (Definition 1)	q	: GDP Deflator (1973 = 100)
Y	: Gross Domestic Product	r	: Long Term Interest Rate
Z	: Imports of Goods	d	: Depreciation Rate

Source: T.T. Hsueh & K.K. Chow, 'A Dynamic Macroeconometric Model for the Hong Kong Economy,' Hong Kong Economic Papers, 1981, forthcoming.

Note: All variables are in the nominal values.

TABLE 2.10

THE ESTIMATED DYNAMIC MODEL

	Structural Equation	R-square
1.	$\Delta C_t = 0.24 + 0.28\ \Delta Y_t + 0.30\ \Delta C_{t-1} + 0.46\ \Delta M_t$ $(0.45)\ (1.95)\ \ (1.35)\ \ (1.13)$	0.80
2.	$\Delta I_t = -0.40 + 0.38\ \Delta Y_t - 0.0011\ \Delta p_t - 0.0073\ I_{t-1}$ $(-2.03)\ (6.74)\ \ (-0.13)\ \ (-0.14)$	0.94
3.	$\Delta M_t = 0.11 + 0.16\ \Delta Y_t - 0.63\ \Delta r_t + 0.25\ \Delta M_{t-1} + 0.13\ \Delta q_t$ $(0.34)\ (1.31)\ \ (-3.42)\ \ (0.64)\ \ (1.77)$	0.84
4.	$\Delta Z_t = -0.44 + 0.32\ \Delta Y_t + 0.17\ \Delta Z_{t-1} + 0.65\ \Delta E_t$ $(-0.77)\ (1.08)\ \ (1.30)\ \ (3.16)$	0.95
5.	$Y_t = C_t + I_t + G_t + E_t - Z_t$	

Source: T.T. Hsueh & K.K. Chow, ibid.

Note: Figures in parentheses are the associated t-values.

The Dynamic Model, though small in size and hence lost a great deal of simultaneity between aggregate economic variables of the economy, can give us some idea about the working of the economic system. From the consumption equation we can see that wealth, measured by the money supply (definition 1), plays a role in the explanation of private consumption expenditure. The money demand equation tells that gross domestic product, interest rate as well as a lagged demand of money explained the effect of demand for nominal money fairly well. Finally total exports of the economy significantly affects the demand of imports.

The Dynamic Model traces the historical path fairly well. However the forecasts made by the model seems to be far from satisfaction. For instance, the nominal gross domestic product forecasted for 1981 is 110,045 Hong Kong million dollars, which is 15 per cent less than the actual figure.

Next we come to the ERC Forecasting Model (or simply ERC Model), developed by the Economic Research Centre of The Chinese University of Hong Kong, and is so far the largest model of the Hong Kong economy. It is a more disaggregated model, and has been used for short term forecasting and structural analysis purposes. The 1979 ERC Model[7] includes 45 equations and 64 exogenous variables. Since there are only 18 observations over the period 1961 to 1978, principal components of pre-determined variables were used in the estimation process, where two-stage least squares method is employed. Moreover the Gauss-Seidel iteration method is used to solve the system. The ERC Model is revised each year to take advantage of data revisions and new research findings. Table 2.11 is a list of variables in this model.

By comparing to the model of Hsueh and Chow, the ERC Model entails greater disaggregation, in particular, the trade, the money and the investment sectors. This enables it to account for majority complexity

TABLE 2.11

LIST OF VARIABLES IN THE ERC MODEL

45 Endogenous Variables		64 Pre-determined Variables	
3	Consumption	2	Government Purchases
3	Investment	2	Lagged Private Consumption
7	Exports	1	Depreciation
5	Income	4	Lagged Monetary Aggregates
2	Labor Force	7	Dummy Variables
2	Wage Rate Index	1	Transfer
3	Production	4	Interest Rates
1	Capacity Utilization	3	Lagged Income
5	Price Index	4	Investment
6	Monetary Aggregates	1	Lagged Capital Stock
2	Tax	3	Lagged Price Index
3	Capital Stock	5	Price Index
		1	World Trade Volume Index
		1	Time
		1	World Tourist Expenditure Index
		2	Lagged Wage Rate Index
		1	Rate of Increase of Monetary Aggregates
		1	Lagged Output
		16	Splines

[1]Figures at the left indicate the number of variables fallen in the corresponding item of variables.

of the economy. Moreover variables are no longer measured in nominal terms except those of the money sector to avoid the money illusion assumed in the Dynamic Model. Lastly senario analysis performed in the ERC Model gives different pictures of the economic conditions in the future while dynamic simulations are useful for analysing the implications of various policy packages.

The forecasting performance of the ERC Model is quite satisfactory in recent years. The annual increase in GDP at 1973 dollars was predicted to be 10.2 per cent in 1980 and in 1981 was 9.7 per cent while the official figures released by the government was 9.7 and 10.0 per cent respectively.

FOOTNOTES FOR CHAPTER II

1. An algebraic macroeconometric model is a macroeconomic model with the relations specified in particular algebraic functions.
2. For a survey of macroeconometric models of the United States economy, see M.D. Intrigilator, Econometric Methods, Techniques and Applications, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1978, chapter 12.
3. L.R. Klein, Economic Fluctuations in the United States 1921-1941, Cowles Commission Monograph No. 11, New York: John Wiley & Sons, Inc., 1950.
4. T.Y. Cheng, The Economy of Hong Kong, Hong Kong: Far East Publications, 1979, p.38.
5. D.H. Robertson, 'The Future of International Trade,' Reprinted in Readings in the Theory of International Trade, American Economic Association, Blackiston Co., 1949, p.50.
6. T.T. Hsueh and K.K. Chow, 'A Dynamic Macroeconometric Model for the Hong Kong Economy,' Hong Kong Economic Papers, 1981, forthcoming.
7. T.B. Lin, 'The ERC Forecasting Model of the Hong Kong Economy,' Southeast Asian Studies, Vol. 17, No. 2, September 1979, pp. 273-90.

CHAPTER III

THEORETICAL DISCUSSION AND RESULTS OF THE QUARTERLY MACROECONOMETRIC MODEL OF THE HONG KONG ECONOMY

In previous chapter we have described the nature and the uses of macroeconometric models. We also reviewed two annual models which have been set up for three principal purposes of econometrics: structural analysis, forecasting and policy evaluation. However if there are sufficient quarterly data for the aggregate economic variables, it will be better to construct a quarterly macroeconometric model because in any instant of time variables surely cannot interact with one another, that is, the simultaneity nature of a system will be more and more vigorous over time. A quarterly model can reduce the specification error, wherever it exists, to a smaller magnitude. Furthermore the most current information can be incorporated into a quarterly model and hence improve the quality of the forecasts made. Thus by mixing the knowledge on the economic background of the small open economy along with our theoretical considerations, we can set up a quarterly macroeconometric model of the Hong Kong economy. In this chapter we outline the structure of this model and present the results obtained. The limitation in the availability of disaggregated quarterly data forces us to analyse only those highly aggregate variables. Our quarterly model is thus of medium size which consists of 18 equations, of which 13 are stochastic relations and 5 are definitional or accounting identities. They link 47 variables, of which 18 are endogenous, 17 are exogenous and 12 are lagged endogenous variables. As our interests are

in the gross domestic product and its components, this medium size model can still serve our purpose well.

The quarterly model we are going to construct includes five sectors, namely, consumption, investment, foreign trade, price and money sectors. In the following sections we first give theoretical considerations in the discussion of individual equations, justify the variables used and interrelate the five sectors by a block diagram. Then a brief discussion on the methods of estimation used is followed by the empirical estimation of the structural equations.

3.1 Discussion of the Quarterly Model

3.1.1 The Consumption Sector

There are two equations in the consumption sector. One is behavioural and the other is a definitional identity. It is assumed that government policies are determined by separate mechanism, and are treated as exogenous. The model only explains the behaviour of households, i.e., the variations in private consumption expenditure.

The simplest consumption function derives from Keynesian economics is a linear relationship between aggregate consumption expenditure and income. Usually disposable income is used when private consumption expenditure is of interest. However the irreconciliation of this relation with the long term data had resulted several suggestive theories into play. These theories, in chronological order of birth, are Relative Income Hypothesis by Duesenburry (1949),[1] Permanent Income Hypothesis by Friedman (1957),[2] and Life-Cycle Hypothesis by Ando and Modigliani (1963).[3] In the present model the youngest one, the Life-Cycle Hypothesis of Consumption, has been used in describing the behaviour of households as consumers because it fits our data best. The match of this hypothesis

with the Hong Kong economy will not be of surprise if one had noted the lack of a general social security of the colony as is often criticised by leaders of workers union as well as social workers from voluntary organisations.

Under the Life-Cycle Hypothesis, there are two variables for the explanation of the variations in private consumption expenditure. Besides the influence of the disposable income of households, private consumption expenditure is also affected by the wealth possesses by the households. It is because people must rearrange their lifetime consumption in relation to their expected income and protect consumption plans from the unexpected falls in income. Both these aims are achieved through saving in the form of accumulation of non-human wealth, for instance save money in banks. Thus both income and wealth of households are important factors in the determination of private consumption expenditure. Furthermore in a general demand theory where consumers are assumed to revise their consumption plans continuously over time so as to maximise their utility, initial stocks of wealth enters as variables in their demand functions. The assumption that consumers plan for their consumptions in the next three months leads us to introduce the wealth in existence at the beginning of each quarter into the explanatory equation of private consumption expenditure of our model.

The most salient feature of every quarterly model is its seasonal pattern of variables. Thus there will often be seasonal dummy variables in the structural equations of the model. For the private consumption expenditure, there will be significant seasonal effects, for example expenditure in the time of Christmas and Lunar New Year should have marked differences from the remaining two quarters. Note that we have to put only three seasonal dummy variables for the avoidance of multi-collinearity trap.

Since we are interested in the quantity demanded under different circumstances, the analysis should be undergone by using real valued variables. The disposable income is measured by the difference between the gross domestic product and the tax paid. Wealth is difficult to measure, and like many other studies, for instance, the Klein-Goldberger Model of the United States economy,[4] we use liquid assets as a proxy which includes savings and time deposits with licensed banks in Hong Kong. The use of this proxy is reasonable since we are now concerning behaviour of consumers and money balances of these consumers are usually spent for goods and services for consumption uses.

The discussion in the above leads us to formulate the following consumption equation for the households:

$$(1) \qquad CP = a_o + a_1(GDP - TAX) + a_2\left(\frac{SDEP + TDEP}{PC}\right)_{-1} + a_3 D1 + a_4 D2 + a_5 D3 + u_1$$

where

- CP = private consumption expenditure in constant 1973 million dollars
- GDP = gross domestic product in constant 1973 million dollars
- TAX = tax revenue of Hong Kong Government in constant 1973 million dollars
- $SDEP$ = savings deposits with licensed banks in current million dollars
- $TDEP$ = time deposits with licensed banks in current million dollars
- PC = consumer price index (A), 100 during July 1973 to June 1974
- u_1 = random disturbance[5]

D1 = seasonal dummy variable, 1 in the first quarter and 0 otherwise

D2 = seasonal dummy variable, 1 in the second quarter and 0 otherwise

D3 = seasonal dummy variable, 1 in the third quarter and 0 otherwise

The total consumption expenditure of the economy is then given by the following identity:

(2) $C = CP + CG$

where C = total consumption expenditure of the economy in constant 1973 million dollars

CG = government consumption expenditure in constant 1973 million dollars

3.1.2 The Investment Sector

The preceeding section is an analysis on the behaviour of people as consumers in their daily life. We now turn to behavioural patterns of people as producers in making their capital expenditures, or investment by private sector as is often called. It includes fixed capital formation as well as the change in stocks of inventory. Similar to the case of consumption expenditure, government also spends in capital goods which is classified as fixed capital formation by public sector. In the present model, this part of the economy's total investment as well as the change in stocks of inventory are treated as exogenous. The reason for the public component is similar to that stated in the preceeding section. For the change in stocks of inventory, its explanation is often unsuccessful or unsatisfactory. This may attribute to the unreliability of the figures

as is admitted by government.[6] Thus only the variations in private fixed capital formation is explained in the model.

Competitive models exist in the literature of economics for the determination of investment made by people. Among them we make use of that by Witte (1963)[7] in our quarterly model. Previous work has found that accelerator principle of investment is not significant in Hong Kong.[8] We are now dealing with variables whose observations are defined on a relatively short period of time. Thus capital formed in one given period will be negligible compared with the great bulk existing. This is just what Witte has stressed in his distinguishable work.

With an assumed fixed amount of capital stock, Witte has shown that investment expenditure depends mainly on the demand of the existing stock of capital which is affected by numerous factors. Among them two are of more importance. The first one is the prosperity of the economy. Usually more profits are expected in boom times and vice versa. This stimulates the demand on the existing capital and hence the investment expenditure. Prosperity is then measured by the gross domestic product of the economy which is consequently expected to have a positive effect on the private capital formation. The second prominent factor in affecting the decisions of producers on capital outlays is the real rate of interest. It is a measure of cost on the investment projects if they are financed by borrowing money from banks or financial intermediaries. Or if they are financed by retained earnings or savings, the rate of interest is a measure of the opportunity cost as the capital expenditure can be substituted for interest-bearing assets. These costs will have adverse effects on the demand of the existing capital stocks, and hence on the private investment expenditure. Note that real rate of interest should be used to compensate for the inflation. Furthermore the accounting system leads to the introduction of lagged values in which we have

made use of the Koyck Lag Model to account for:

$$IPV = a + b \sum_{o}^{\infty} w^{i} GDP_{-1-i} + c \sum_{o}^{\infty} w^{i} R_{-1-i} + u$$

where IPV is the private investment, R is the real rate of interest and u is the disturbance term. The geometric weight w is a value lies between zero and one. This equation can be transformed into:[9]

$$IPV = a(1-w) + b\ GDP_{-1} + c\ R_{-1} + w\ IPV_{-1} + (1-w)u$$

Thus we see that private investment depends only on last period's gross domestic product, real rate of interest and its own lagged value. The present model measures the real rate of interest by the difference between banks' best lending rate and the inflation rate indicated by the rate of change of the gross domestic product deflator. Consequently we have the following specification for the gross domestic fixed private capital formation:

$$(3) \qquad IPV = b_o + b_1 GDP_{-1} + b_2\left(\frac{HSBPR_{-1}}{4} - \frac{P_{-1} - P_{-2}}{P_{-2}} \times 100\right) + b_3 IPV_{-1} + u_3$$

where IPV = gross domestic fixed private capital formation in constant 1973 million dollars

HSBPR = Hong Kong & Shanghai Bank's quoted best-lending rate in per cent per annum

P = gross domestic product deflator, 100 in 1973

The total gross domestic fixed capital formation is defined as

the sum of private and public sectors:

(4) $CF = IPV + IG$

where CF = gross domestic fixed capital formation in constant 1973 million dollars

IG = gross domestic fixed capital formation by public sector in constant 1973 million dollars

3.1.3 The Foreign Trade Sector

There are five equations in the foreign trade sector of the model. Four of them are behavioural equations and the rest is a definitional identity. We first investigate the source of the foreign exchange revenues for the the economy, i.e., the exports of goods and services of the economy.

The Domestic Exports of Goods Equation

Exports of merchandises is the major source of foreign exchange revenues of the colony with which imports of necessities are paid. The exports include domestically produced goods and re-exports. The latter component is in a large degree dependent on outside factors such as the modernisation of the People's Republic of China and hence is treated as exogenous in the model. As for the domestic exports, United States is by far the largest outlet of the domestically-produced goods which accounts for about 40 per cent of the total in the decade of seventies. Thus the performance of the economy of United States will certainly casts great influence to our domestic exports of goods. Moreover it can serve as an indicator to the world-wide economic performance on which exports of a small open economy like Hong Kong largely depends.

Besides the national incomes of the foreign markets, keen competitions from other countries, especially those from developing nations such as Taiwan and South Korea, is also a key factor for the determination of our domestic exports. We have used two variables for this aspect. One is the the relative price of the domestic exports to the price of world exports. Another is the domestic currency exchange rates. Ideally a weighted index of these rates based on the share of different nations' imports of Hong Kong product should be used to perform the task. However figures of early years are not available and hence we used a trade-weighted index for the substitution.

The fourth explanatory variable used is the lagged one quarter's domestic exports. Since majority of the domestic exports are manufactured goods for consumption use, the inclusion of the lagged variable is justified in view of the consumption habits of people in the importing countries.[10]

Finally dummy variables are added as in the private consumption expenditure equation. Since domestic exports of the economy are calculated on freight-on-board basis and commodities are often shipped in the second and third quarter to meet the large demand of consumption goods in Western countries by Christmas, seasonal dummies should show significant differences in the quarterly figures of domestic exports.

Totally we have the domestic exports of goods equation as:

$$(5) \qquad DEG = c_o + c_1 USAGNP + c_2\left(\frac{PE}{PWE}\right) + c_3 ER + c_4 DEG_{-1} + c_5 D1 + c_6 D2 + c_7 D3 + u_5$$

where DEG = domestic exports of goods in constant 1973 million dollars

USACNP = gross national product of the United States in constant 1973 billion dollars, seasonally adjusted at annual rates

PE = unit value index of domestic exports, 100 in 1973

PWE = unit value index of world exports, 100 in 1973

ER = trade-weighted effective exchange rate index, 100 on 18th December, 1971 when the Smithsonian Agreement was reached

The total exports of goods of the economy is the sum of the domestic exports and the re-exports. This is expressed as an identity:

(6) EG = DEG + REG

where EG = total exports of goods of the economy in constant 1973 milllion dollars

REG = re-exports of goods in constant 1973 million dollars

Exports of Services Equation

Another source of foreign exchange revenues of the economy is the exports of services which are the sales of the economy to the rest of the world of non-factor services. It consists of expenditures of foreign tourists in the colony, cargo and passenger revenue, disbursement of foreign companies in Hong Kong and other revenues derived from a small number of miscellaneous transactions. Besides the first component, there is no system to record the contributions of individual factors before 1978. Methods of interpolation and disaggregation mentioned in

chapter one are then used to obtain the quarterly exports of services of the economy.

The components that make up the exports of services hint us to use three variables for the explanation of its variations. The first one is the number of incoming tourists to the colony. Their spending on shopping, accomodation, meals and entertainment are all counted as exports of services by the economy. Hence we expect an increase in exports of services if the number of incoming tourists is greater.

The second variable used in the equation is the price level of the economy, especially that of consumer goods. About 60 per cent of the tourists' expenditures are spent on shopping.[11] Hence one of the reasons that tourists will spend less during their stay in Hong Kong is that the price of consumer goods is higher.

Finally the total volume of trade shows the degree of activities which link the domestic economy with the outside world. Foreign companies have to set up their offices in Hong Kong to do business not only with the the colony, but also with the People's Republic of China as in recent years China is more open in its foreign trade with the Western world. The expenditures of these companies in the region will evidently grow with the total volume of trade which justifies the inclusion of this latter variable into the equation. Thus the exports of services equation is formulated as:

$$(7) \qquad ES = d_o + d_1 TOUR + d_2 PC + d_3 (EG + ES + MG + MS) + u_7$$

where ES = exports of services in constant 1973 million dollars

MG = imports of goods in constant 1973 million dollars

MS = imports of services in constant 1973 million dollars

TOUR = incoming tourists to the colony in thousand of people

Note that seasonality of the dependent variable, even if it exists, has been accounted for by the explanatory variable 'TOUR'. Thus no seasonal dummy variables is needed in the equation.

Imports of Goods Equation

So far we have viewed how the economy earns its foreign exchanges through the exports of goods and services. The leakage of these exchanges are through imports of goods and services. We shall first discuss the imports of merchandises and leaves that of services to be the last topic in the consideration of the foreign trade sector of our quarterly model.

Deriving from a general demand theory, imports of an economy depend on both income and price factors. For the income of an economy, either gross domestic product or disposable income will be a measure. The selection of the measure depends on the characteristics of the economy one is faced with. For instance; in the import demand equation of the Klein-Goldberger Model (1955), disposable income rather than the gross domestic product of the economy was used.[12] It is because most of the imports of United States are finished goods for consumption use or in case of raw materials imports. They are manufactured into finished consumer goods. Thus disposable income will be a better income variable to be used in the determination of imports demand of that particular economy. For Hong Kong, on the contrary, we suggest the use of gross domestic product as the income factor which influences the magnitude of the imports demand. The reason is that the economy falls short of almost all type of natural resources and thus raw materials imports are pre-requisites for domestic exports. Imports of merchandises

are not solely for consumption, but also for export-production.

Besides the income factor measured by the gross domestic product of the economy, there is price factor to account for the substitution between domestically produced and foreign made commodities. Though the effect may not be so significant by the highly dependence to imports of the colony, it is still accounted for in the equation by the change in terms of trade, i.e., change in the relative price of domestic exports to imports.

Finally seasonal dummy variables are put into the equation to account for the seasonality of domestic exports of goods and consumption mentioned in the preceeding. Consequently the imports demand function of the model is specified as:

$$(8) \qquad MG = e_o + e_1 GDP + e_2 \left(\frac{PE}{PM} - \frac{PE_{-1}}{PM_{-1}}\right) + e_3 D1 + e_4 D2 + e_5 D3 + u_8$$

where PM = unit value index of imports, 100 in 1973

Imports of Services Equation

Imports of services are the purchases of non-factor services from the rest of the world by the domestic economy. Similar to the exports of services, there lacks a system of recording necessary information for its calculation. Thus we use a token estimate of the net exports of services (exports less imports of services) supplied officially by the government.[13] We have obtained in the preceeding the values of exports of services by interpolation and disaggregation methods, and now by subtracting the net exports of services from the gross exports of services we arrive at figures on the imports of services of the economy.

Imports of services for Hong Kong economy include mainly the expenditure of residents abroad, passenger fares and miscellaneous disbursement of local shipping and air transportation companies in the foreign nations. The first two components of this leakage of foreign exchanges are principally derived from the expenditures of local residents in their whole trips as tourists abroad. Most studies use the disposable income as a determinant for the demand of this kind of services.[14] This is reasonable if the observations on variables are made in a longer period of time, say, a year. However if the period defined is relatively short, as in the present case one quarter of a year, the effect of disposable income on the demand of tourism by local residents will not be so significant. On the contrary, people will save their income for several periods of time and enjoy a 'luxurious trip'. Hence saving will be a more influential factor in the determination of the local tourism demand. The wealth variable defined earlier in the consumption equation is then used as an explanatory variable in the imports of services equation.

Besides the role played by the wealth variable in the demand of tourism by the local residents, that by the lagged value of the endogenous variable will be of great importance in the explanation of the variations in the imports of services. The demonstration effect derives from the friends and relatives of residents justified the use of this lagged variable.

Like the case of exports of services, disbursements of local shipping and air transportation companies in foreign nations will be accounted for by the introduction fo the total volume of trade variable. The size and hence the overhead costs of these companies will grow synchronously with the trading activities of the domestic economy with the outside world.

The seasonal dummy variables are included as explanatory variables to account for the seasonality exists in both the local tourism and imports demand. The final specification of the imports of services equation will then be:

$$(9) \qquad MS = f_o + f_1\left(\frac{SDEP + TDEP}{PC}\right)_{-1} + f_2(EG + ES + MG + MS) + f_3 D1 + f_4 D2 + f_5 D3 + u_9$$

where MS = imports of services in constant 1973 million dollars

An Accounting Identity of the Gross Domestic Product

There are three approaches in calculating the gross domestic product of an economy, namely the expenditure approach, income approach, and the production approach. The present model uses the expenditure approach which measures gross domestic product as the sum of expenditures on consumption, investment and net exports to the rest of the world which can be expressed by the following accounting identity:

$$(10) \qquad GDP_{,} = C + CF + IS + EG + ES - MG - MS$$

where IS = increase in stocks of inventory in constant 1973 million dollars

3.1.4 The Price Sector

We have seen that several price variables play an important role in affecting the performance of the economy through consumption, investment as well as foreign trade. Thus it is also of interest to analyse these price variables within the setting of the present model. A price sector is then developed which is composed of three behavioural

equations. These equations try to explain the variations in the unit value index of domestic exports, consumer price index (A) and the gross domestic product deflator. The unit value index of imports is treated as exogenous in the model by the highly dependence of imports of this small open economy. External forces, such as the administration policy of O.P.E.C., rather than internal factors of the economy affect significantly the variations of the prices of imports.

Unit Value Index of Domestic Exports Equation

The demand for the domestically produced goods by foreign countries has increased by about two-folds during the period 1973 to 1980 in real terms. Meanwhile the price of these exports has also risen to a level which is a little bit less than doubled. Since there are always keen competitions from other developing countries, prices of our domestic exports will in largest part reflected the costs involved in their manufacturing. Naturally the price of imports, measured by the unit value index of imports, is then the dominant influential factor by the fact that majority of the domestic exports are manufactured goods. Raw materials imported from abroad will incur a significant cost in the production of these manufactured goods.

Besides raw materials or semi-manufactured goods imported from abroad, labor is also a necessary factor in the production of domestic exports. The wage paid to the labourers is also part of the costs of the exports. Thus wage of labourers, especially those work in manufacturing industry, is another crucial factor in the determination of the domestic exports prices.

Finally the price level of the economy, indicated by the consumer price index, is used to account for the remaining costs of production of exporting goods. For instance, large amount of water and electricity

are used by the textile industry which still contributes much in the domestic exports of the economy.

The above discussion leads to the following specification of the unit value index of domestic exports:

(11) $PE = g_o + g_1 PM + g_2 WMF + g_3 PC + u_{11}$

where WMF = nominal average daily wage index of workers in manufacturing industry (including fringe benefit), 100 during July 1973 to June 1974

Consumer Price Index (A) Equation

There are two measures of the inflation rate in Hong Kong. One is the rate of change of consumer price index and the other is the rate of change in gross domestic product deflator. The former index shows the price level of consumer goods such as foodstuffs and housing; thus is suitable for the people as consumer at large. The latter deflator indicates the general price level of the economy and will also be of importance in a macro analysis. These two measures are highly inter-related as can be seen from the fact that private consumption expenditure has a share of about 70 per cent in the total of gross domestic product. Thus the specifications are similar and we first focus on the consumer price index, leaving the discussion of gross domestic product deflator in the latter paragraphs.

As is often mentioned in the preceeding discussions, Hong Kong falls short of natural resources and imports play an important role in the subsistence of the people. The domestic price level of the consumer goods will then be affected by the price of the 'inevitable' imports.

The second variable used to explain the variations of consumer price index is the money supply of the economy, measured under definition two since it consists of savings deposits with which the consumers spend. As the money supply increases, the relatively fixed amount of commodities will be 'chased' by a larger bulk of money and thus the price of goods are bid up. However conflicting views co-exist in the degree of affectiveness of the money supply and import prices on the consumer price index.[15] We shall come back to this problem after the empirical estimation of the model has been worked out.

Lastly the lagged values of the dependent variable is added to the equation to account for the adjustment over time. Thus we have:

$$(12) \qquad PC = h_o + h_1 PM + h_2 M2 + h_3 PC_{-1} + u_{12}$$

where M2 = money supply (definition 2) in current million dollars

Gross Domestic Product Deflator Equation

The gross domestic deflator measures the general price level of the economy and its change over time can be explained similarly to arguments given for the consumer price index (A). As have been pointed, consumption expenditure has a share of about 70 per cent in the gross domestic product and thus a rise in the price of consumer goods will also signify an increase in the overall price level. Thus we substitute the consumer price index for the lagged variable in equation (12) as the specification of the gross domestic product deflator equation:

$$(13) \qquad P = i_o + i_1 PM + i_2 M2 + i_3 PC + u_{13}$$

3.1.5 The Money Sector

The important role played by the money supply in the determination of the price level of the economy has just been seen in the price sector. This supply of money is defined as the sum of various deposits with licensed banks and currency in circulation among hands of non-bank public. The savings and time deposits have been used a proxy of the non-human wealth which influences greatly the private consumption expenditure as shown in equation (1). An explanation to their variations is then necessary for the completion of the model.

The Savings Deposits Equation

Savimgs deposits with licensed banks of Hong Kong have been increased more than five times in nominal terms during the period 1973 to 1980. This can be attributed to the growth of the economy in that nominal gross domestic product has also tripled itself in the same span of time. People's savings in absolute terms will move synchronously with money incomes.

Deposits are stocks of money stored in financial institutions. They are withdrawn for expenditures or change into other interest-bearing assets. The habits of people in their daily life and the insensitivity to portfolio adjustments hint us to use lagged dependent variable throughout the behavioural equations in the money sector of the model. The insensitivity is attributed to the relatively short time period between observations.

One may argue that the rate of interest will also affect the savings deposits by people with licensed banks. We accept this but did not use it as an explanatory variable in the equation because savings deposits in Hong Kong are characterised for their convenient withdrawl and banks are regarded as save places where money is stored. Thus

the specification of the savings deposits equation is:

$$(14) \qquad SDEP = j_o + j_1(P \cdot GDP) + j_2 SDEP_{-1} + u_{14}$$

The Time Deposits Equation

Time deposits are similar to the savings deposits in that both are recognised as liquid assets. However the demand for this deposit lies on the fact that the interest yields are greater. Thus interest rate will be an important factor in its explanation. The nominal gross domestic product and lagged dependent variables enter as explanatory variables by similar arguments as for equation (14):

$$(15) \qquad TDEP = k_o + k_1 TDEP_{-1} + k_2 R90 + k_3(P \cdot GDP) + u_{15}$$

where R90 = interest rate paid to three-month time deposits with licensed banks

The three-month time deposits rate is used because we have assumed that people will revise their consumption plans at the beginning of each quarter.

The Demand Deposits Equation

Demand deposits are another type of deposits with licensed banks. They distinguish themselves from others in that withdrawal by cheque being possible without notice. No interest is paid to these deposits and thus time deposits will be a close substitute through the playing of interest yield. Moreover the more active is the economy, the greater the demand will be on this kind of deposits. With the evolution of Hong Kong as a financial centre in the decade of seventies we expect a high income elasticity of demand deposits. This will be verified in the structural analysis of the estimated model. The specification of

the demand deposits equation is then specified as:

$$(16) \qquad DDEP = l_o + l_1 R90 + l_2 (P \cdot GDP) + l_3 DDEP_{-1} + u_{16}$$

where DDEP = demand deposits with licensed banks in current million dollars

The Currency in Circulation Equation

Various kinds of deposits have been discussed. There remains the last component for the summing up to the total money supply (definition 2). The component is known as 'Legal Tender Coins and Notes in Hands of Non-Bank Public', or simply called the currency in circulation. It is obvious that its demand is for small amount transaction purposes and thus is determined by the volume of transaction of the economy. Hence we have the following specification:

$$(17) \qquad CURR = m_o + m_1 (P \cdot GDP) + m_2 CURR_{-1} + u_{17}$$

where CURR = currency in circulation in current million dollars

Definitional Identity of Money Supply

The money sector is closed with a definitional identity of the money supply. The supply of money can be defined in several ways and the present model defines it as the total of savings deposits, time deposits, demand deposits and currency in circulation. It is often referred to as the money supply of definition two (M2):

$$(18) \qquad M2 = SDEP + TDEP + DDEP + CURR$$

The money supply of definition three (M3), which is defined as M2 plus deposits from the non-bank and non-deposit-taking company public with registered deposit-taking companies, is not discussed in this study because the series of observations available is not long enough for such kind of analysis in the present study.

This ends our theoretical discussion on the quarterly model. The variables are highly interrelated and the links among the five sectors are shown in a block diagram in Figure 3.1 below.

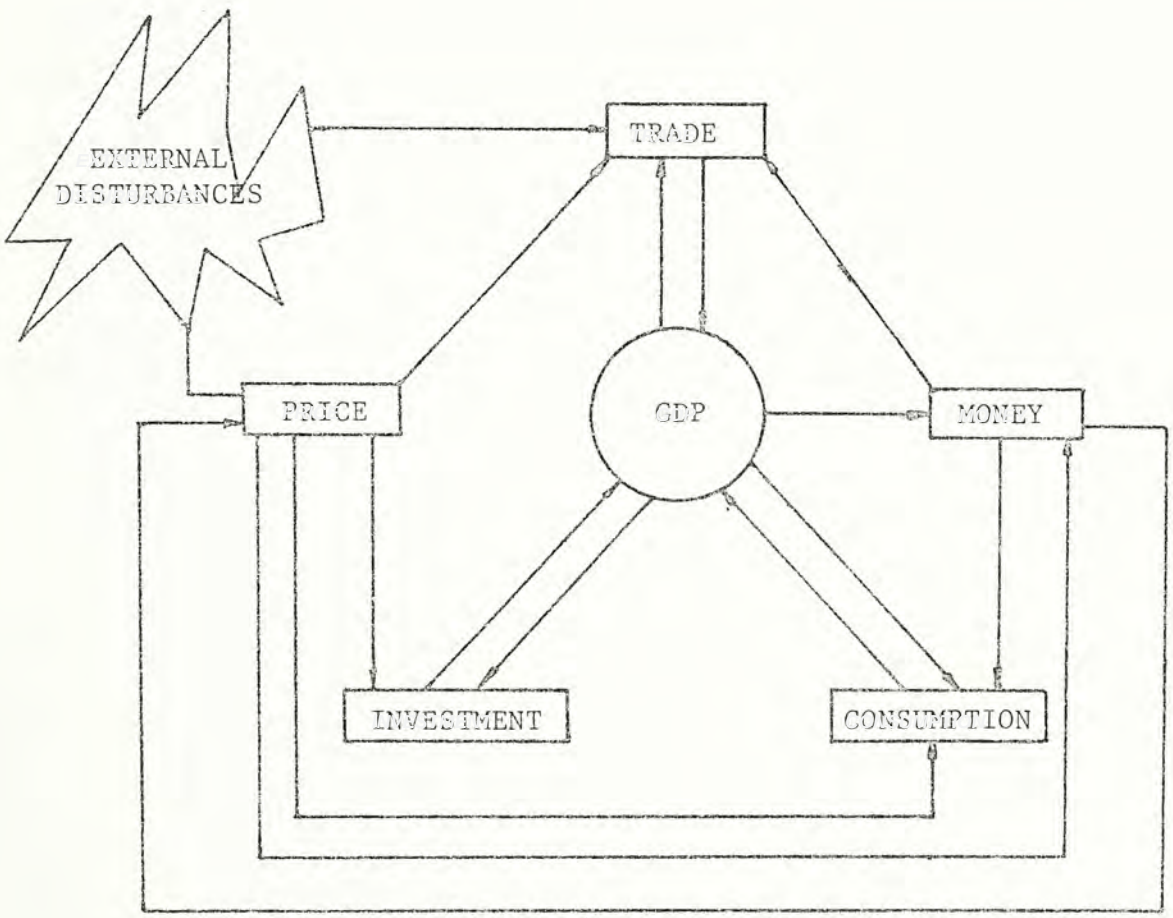


Figure 3.1

A Block Diagram For The Quarterly
Macroeconometric Model

3.2 A Brief Review on the Estimation Methods

The theoretical basis for the specification of the quarterly model has been given in the preceeding section. Before going to empirical estimation of the model, we first have a brief review on the estimation methods of macroeconometric model commonly used.

There are many equations in a macroeconometric model and each of them has its own set of parameters. Estimation of these parameters can be performed in two different ways. One is known as single equation estimation where ordinary least squares method (OLS) is often employed and the other is known as system estimation. Under certain basic assumptions, the estimated parameters will be best, linear and unbiased by the OLS method.[16] Furthermore the estimator is consistent.[17] However all except the linear property will be lost whenever one applies the OLS method to estimate system of equations such as ours. The following is an illustration.

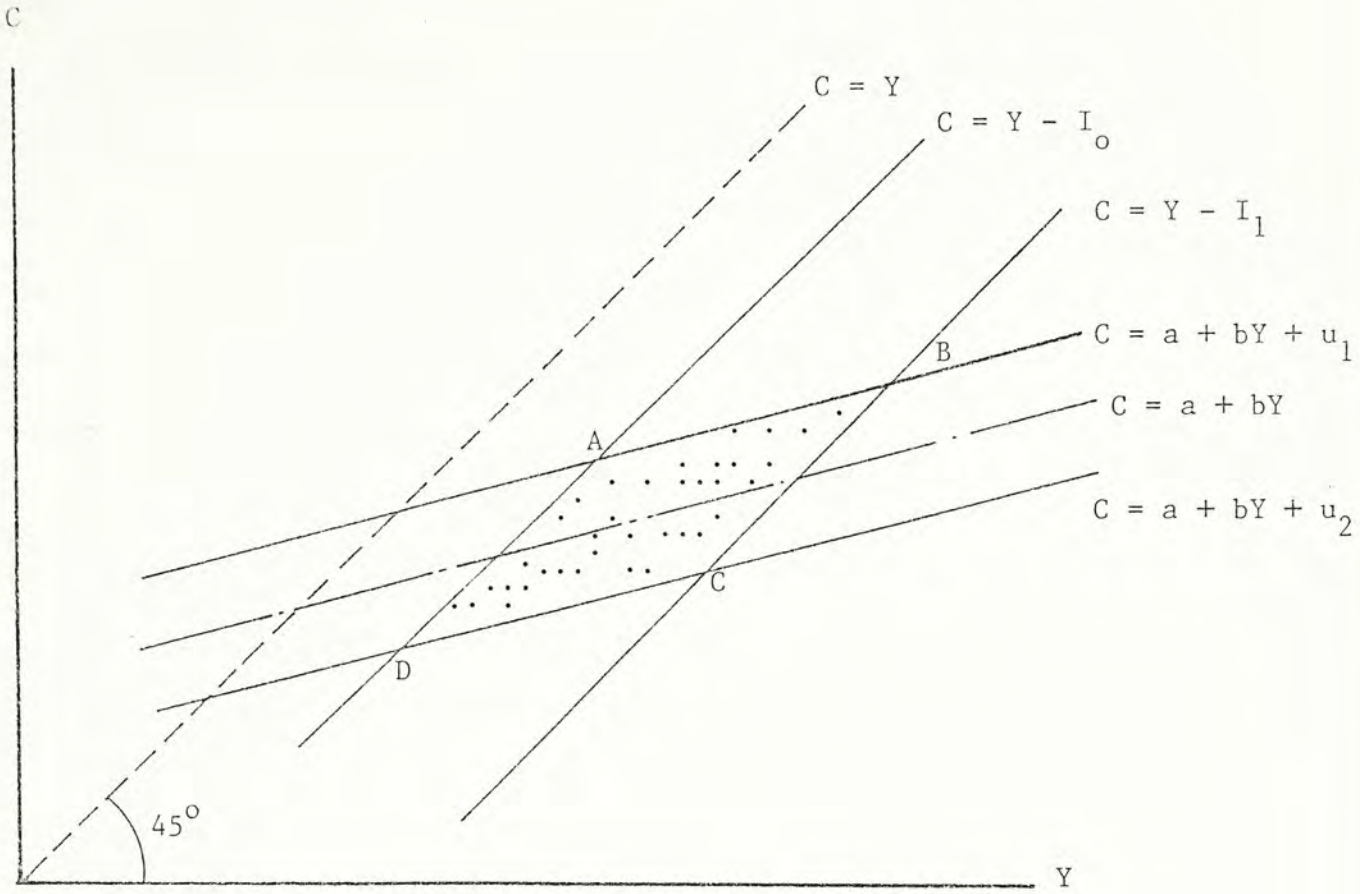
Suppose we have a closed economy where the total income of the economy (Y) consists of consumption expenditure (C) and investment (I), the latter is assumed to be exogenous. The most simple Keynesian consumption function works in the system under investigation. We can then express the system as:

$$C = a + b\,Y + u$$

$$Y = C + I$$

where u is the disturbance.

If we are requested to estimate the parameters a and b, problems will arise as can be seen from figure 3.2. Here we have assumed that investment is uniformly distributed between I_o and I_1 ($I_1 > I_o$) and the disturbance u is equally likely to take any value between u_o and u_1



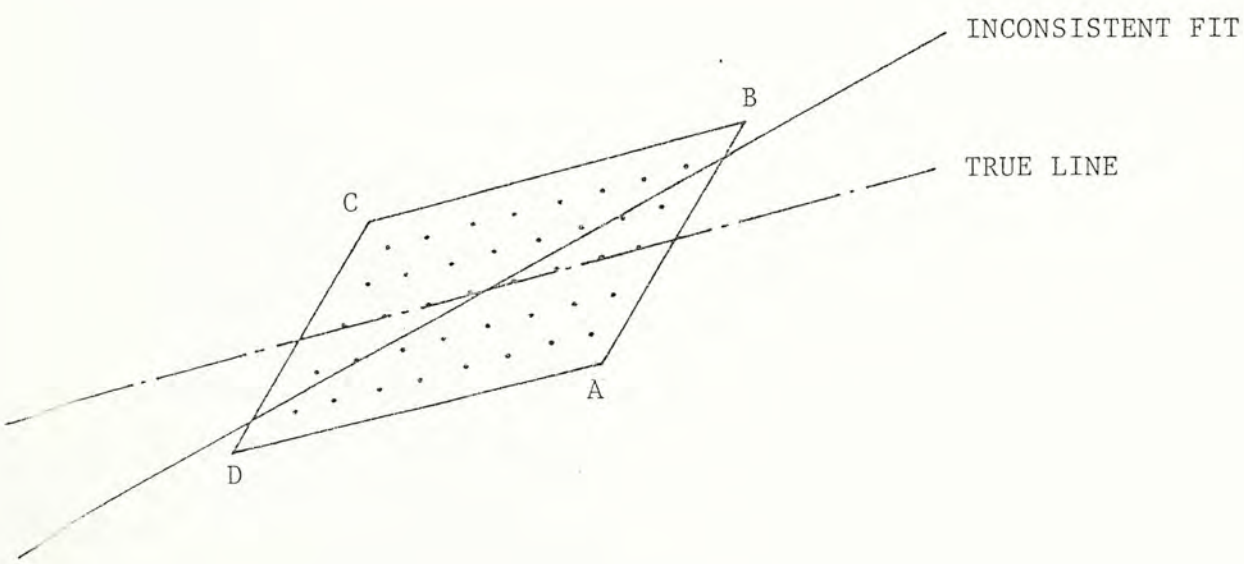


Figure 3.2 Inconsistency of the OLS Estimator

($u_o < u_1$). Thus the observed consumption expenditure and income will be in the parallelogram ABCD. If ordinary least squares method is used for the estimation of the consumption function, observations around B and D will pull the regression line deviate from the true line. No matter how large the sample is, the problem cannot be eased. This shows that OLS method will result in inconsistent estimators in a simultaneous equation model.

One can easily see that inconsistency of the OLS estimators lies heavily on the dependency between the explanatory variables and the disturbances in each structural equation within a system of equations. Two-stage least squares (2SLS) method of estimation eases the problem by making use of the property that predicted value of the dependent variable will be uncorrelated with the disturbances in using OLS method of estimation. Estimators derived from this method, which first regresses the endogenous variables on all pre-determined variables by OLS method and then substitutes the predicted values for the endogenous variables in each structural equation, will be consistent which is one of the desired properties of a good estimator.

The above two methods, ordinary least squares method and two-stage least squares method, are single equation estimation methods which do not utilise all the information embedded in the system. By combining the two-stage least squares method and the seemingly unrelated regression method,[18] the resultant estimator will both be consistent and more efficient. Furthermore the estimator, which is called the three-stage least squares (3SLS) estimator, is asymptotically normally distributed whenever the disturbances assumed the same distribution.

3.3 Empirical Results of the Model and its Implication

As the three-stage least squares method is in general superior to the two-stage least squares method by its gain in efficiency of estimation, we use it to estimate the equations of the model specified in earlier sections. The estimation period is from the fourth quarter of 1973 to the fourth quarter of 1980, a total of 29 observations. The estimated model is presented in the following pages.

We can see from the results that all estimated parameters have the sigh as expected and most of them are significantly different from zero at five per cent level of significance. From the consumption equation, marginal propensity to consume is 0.24 which means that an increase in one million dollars of income of households will result an increase of 0.24 million dollars in private consumption expenditure on the average. However this effect is only an immediate one since this quarter's increase in gross domestic product will have a positive effect in various deposits which induces further expenditure in the following quarters by the wealth effect. The process continues with diminishing effects and the long run marginal propensity to consume is 0.83 which means that an additional 0.59 (0.83 - 0.24 = 0.59) million dollars will be spent by households in consumption in the future as the lagged responses to the unit increase in gross domestic product. This supports our view that savings in the form of non-human wealth greatly affects the expenditure of people. The figure we have found is much lower than that obtained by a similar work done. The long run marginal propensity to consume is found to be 0.96 which seems to be too close to unity.[19]

The second interesting feature of the economy we found in the consumption equation is on its seasonal pattern of the private consumption expenditure. The seasonal dummy variables suggests that people spend

THE ESTIMATED QUARTERLY MACROECONOMETRIC MODEL

1. $CP = 1216.63 + 0.24(GDP - TAX) + 14.51\left(\frac{SDEP + TDEP}{PC}\right)_{-1} - 532.10\ D1 - 774.69\ D2 - 959.66\ D3$

   (2.73) (2.87) (7.32) (-3.10) (-5.61) (-6.52)

2. $C = CP + CG$

3. $IPV = -490.73 + 0.11\ GDP_{-1} + 0.63\ IPV_{-1} - 13.11\left(\frac{HSBPR_{-1}}{4} - \frac{P_{-1} - P_{-2}}{P_{-2}} \times 100\right)$

   (-2.76) (3.47) (5.15) (-1.40)

4. $CF = IPV + IG$

5. $DEG = -2397.83 + 4.99\ USAGNP + 0.61\ DEG_{-1} - 15.22\ ER - 623.00\ \frac{PE}{PWE} - 672.02\ D1 + 585.39\ D2 + 647.59\ D3$

   (-0.77) (2.75) (5.02) (-1.15) (-0.39) (-3.24) (2.22) (3.13)

6. $EG = DEG + REG$

7. $ES = 400.56 + 2.33\ TOUR - 6.51\ PC + 0.074\ (EG + ES + MG + MS)$

   (2.04) (5.08) (-2.70) (7.03)

8. $MG = -3897.98 + 1.22\ GDP + 8674.22\left(\frac{PE}{PM} - \frac{PE_{-1}}{PM_{-1}}\right) - 266.55\ D1 + 184.76\ D2 - 1034.70\ D3$

   (-5.01) (19.67) (1.08) (-0.79) (0.55) (-2.81)

9. MS = $-345.75 + 1.77\left(\frac{SDEP + TDEP}{PC}\right)_{-1} + 0.021(EG + ES + MG + MS) + 35.47\ D1 - 7.22\ D2 + 8.36\ D3$

(-5.45) (4.66) (3.68) (1.69) (-0.47) (0.51)

10. GDP = C + CF + IS + EG + ES - MG - MS

11. PE = $10.22 + 0.13\ WMF + 0.73\ PM + 0.05\ PC$

(1.86) (2.84) (7.95) (0.38)

12. PC = $14.65 + 0.22\ PM + 0.54\ PC_{-1} + 0.00019\ M2$

(1.90) (5.28) (5.74) (2.81)

13. P = $28.27 + 0.29\ PM + 0.35\ PC + 0.00033\ M2$

(2.51) (3.50) (1.91) (3.13)

14. SDEP = $-1392.37 + 0.83\ SDEP_{-1} + 0.0037(P \cdot GDP)$

(-1.28) (7.03) (1.87)

15. TDEP = $-490.5 + 0.77\ TDEP_{-1} + 168.36\ R90 + 0.0035(P \cdot GDP)$

(-0.89) (10.34) (3.25) (3.61)

16. DDEP = $-1018.93 + 0.64\ DDEP_{-1} - 74.67\ R90 + 0.0039(P \cdot GDP)$

(-2.82) (7.12) (-2.38) (4.83)

17. CURR = $9.20 + 0.96\ CURR_{-1} + 0.00024(P \cdot GDP)$

(0.11) (16.95) (1.55)

18. M2 = SDEP + TDEP + DDEP + CURR

Note: Figures in paratheses are the t-values of the corresponding parameter estimates.

List of Variables Used in the Quarterly Model

C^* = total consumption expenditure of the economy in constant 1973 million dollars

CF^* = gross domestic fixed capital formation in constant 1973 million dollars

CG = government consumption expenditure in constant 1973 million dollars

CP^* = private consumption expenditure in constant 1973 million dollars

$CURR^*$ = currency in circulation among hands of non-bank public in current million dollars

$CURR_{-1}$ = one-quarter lagged currency in circulation among hands of non-bank public in current million dollars

D1 = seasonal dummy variable, 1 in the first quarter of a year and 0 otherwise

D2 = seasonal dummy variable, 1 in the second quarter of a year and 0 otherwise

D3 = seasonal dummy variable, 1 in the third quarter of a year and 0 otherwise

$DDEP^*$ = demand deposits with licensed banks (excluding those with deposit-taking companies) in current million dollars

$DDEP_{-1}$ = one-quarter lagged demand deposits with licensed banks (excluding those with deposit-taking companies) in current million dollars

DEG^* = domestic exports fo merchandises in constant 1973 million dollars

DEG_{-1} = one-quarter lagged domestic exports of merchandises in constant 1973 million dollars

EG^{*} = total exports of merchandises in constant 1973 million dollars

ES^{*} = exports of services in constant 1973 million dollars

ER = trade-weighted effective exchange rate index, 100 on 18th December, 1971 when the Smithsonian Aggrement was reached

GDP^{*} = gross domestic product of the economy in constant 1973 million dollars

GDP_{-1} = one-quarter lagged gross domestic product of the economy in constant 1973 million dollars

$HSBPR_{-1}$ = one-quarter lagged Hong Kong & Shanghai Bank's quoted best-lending rate in per cent per annum

IG = gross domestic fixed capital formation of public sector in constant 1973 million dollars

IPV^{*} = gross domestic fixed capital formation of private sector in constant 1973 million dollars

IPV_{-1} = one-quarter lagged gross domestic fixed capital formation of private sector in constant 1973 million dollars

IS = increase in stocks of inventory in constant 1973 million dollars

$M2^{*}$ = total money supply (definition 2) in current million dollars

MG^{*} = imports of goods in constant 1973 million dollars

MS^{*} = imports of services in constant 1973 million dollars

MS_{-1} = one-quarter lagged imports of services in constant 1973 million dollars

P^* = gross domestic product deflator, 100 in 1973

P_{-1} = one-quarter lagged gross domestic product deflator, 100 in 1973

P_{-2} = two-quarter lagged gross domestic product deflator, 100 in 1973

PC^* = consumer price index (A), 100 during July 1973 to June 1974

PC_{-1} = one-quarter lagged consumer price index (A), 100 during July 1973 to June 1974

PE^* = unit value index of domestic exports, 100 in 1973

PE_{-1} = one-quarter lagged unit value index of domestic exports, 100 in 1973

PM = unit value index of imports, 100 in 1973

PM_{-1} = one-quarter lagged unit value index of imports, 100 in 1973

PWE = unit value index of world exports, 100 in 1973

REG = re-exports of goods in constant 1973 million dollars

R90 = three-month time deposits rate in per cent per annum

$SDEP^*$ = savings deposits with licensed banks in current million dollars

$SDEP_{-1}$ = one-quarter lagged savings deposits with licensed banks in current million dollars

$TDEP^*$ = time deposits with licensed banks (excluding those with deposit-taking companies) in current million dollars

$TDEP_{-1}$ = one-quarter lagged time deposits with licensed banks (excluding those with deposit-taking companies) in current million dollars

TAX = tax revenue of government in constant 1973 million dollars

TOUR = number of incoming tourists in thousand people

USAGNP = gross domestic national product of the United States in constant 1973 billion US dollar, seasonally adjusted in annual rates

WMF = nominal average daily wage index of workers in manufacturing industry, 100 during July 1973 to June 1974

Note: Variables with an asterisk are endogenous variables, others are pre-determined variables in the model.

the most in the fourth quarter of a year. This may be a result of weather and Christmas spending.

For the investment sector of the model, like many studies for the Hong Kong economy, interest rate does not show significant effect to the private fixed capital formation. On the contrary the gross output of the economy in the past periods affect the quantity of capital formation prominently. This reveals the fact that expectation of profit is an important factor in producers' decision processes to spend their money on capital goods.

The equations of the foreign trade sector of the model also suggest something notable. From the domestic exports of goods equation one can see that foreign nations influence the economy in a great extent. The estimated coefficients of the variables 'USAGNP' and 'DEG' are 4.99 and 0.61 respectively. This says that an increase of one billion US dollar in the gross national product of United States will induce on the average 4.99 million dollars increase in the demand of the colony's exports (domestically produced) as an immediate impact and a total rise of 12.8 million dollars ultimately. By assuming that a unit rise in the United States demand for Hong Kong's domestic product has no other effect on the colony's domestic exports, the above can also hold true for those domestic exports with United States as destination. This is because

$$\begin{aligned} 4.99 &= \partial DEG/\partial USAGNP \\ &= (\partial DEG/\partial DEG_{USA})(\partial DEG_{USA}/\partial USAGNP) \\ &= \partial DEG_{USA}/\partial USAGNP \end{aligned}$$

where DEG_{USA} is the domestic exports of the colony to United States.

With an average exchange rate of one US dollar to 4.9 dollars

of domestic currency over the estimation period 1973 to 1980, this reveals that the American's marginal propensity to import Hong Kong products is 0.001 in the short run and 0.0026 in the long run. This is consistent with the result found in a notable work of Professor T.C. Lau[20] who has found that the marginal propensity to import of United States is 0.076 and 0.1075 in the short and long run respectively by recognising that Hong Kong product has a share of about two per cent in the imports of United States.

The seasonal dummies also reflect the fact that demand for domestic products from abroad is the greatest in the third quarter for institutional reason previously explained. Furthermore the price variables do not show significant effect on the endogenous variable and hence we conclude that, in the estimation period, price does not significantly influence the performance of Hong Kong's domestic exports. The competitiveness of Hong Kong domestic exports lies on their qualities rather than on the lower production costs.

For the leakage aspect, the marginal propensity to import for the economy is 1.22 which means that an increase in one million dollar of income will induce, on the average, 1.22 million dollars of imports. The great leakage is due to the lack of natural resource of the economy which is a pre-requisite for both consumption and production of exporting commodities.

The income elasticity of imports, which is the product of the marginal propensity to import and the ratio of gross domestic product to imports of goods, is estimated to be 1.42. This is matched with the fact that majority imports are capital goods and luxuries for consumption which have high income elasticities. Other study has estimated this elasticity to be 1.06 during the period 1966 to 1977[21] which seems to be a little bit small compared with ours. The underestimation is also

supported by an earlier study on the imports of the colony.[22] In this study the income elasticities of different components of imports were estimated as follows:

foodstuffs	(M_f)	0.745
consumer goods	(M_c)	1.115
raw materials	(M_r)	1.034
capital goods	(M_i)	2.573

Now it is easy to show that the income elasticity of the total imports of goods is given by the weighted sum of the income elasticities of its various components, the weights being the respective share of the components during the period 1968 to 1972. The income elasticity of the total imports is no less than 1.15.

Turning to the price elasticity of the colony's imports of merchandises, it is estimated to be -0.85. This inelastic nature of the price of imports is attributed to the highly dependency of the economic activities throughout the colony.

From the estimated parameters of the seasonal dummy variables, we can see that Hong Kong imports the least foreign products in the third quarter while the differences between remaining quarters are not significant.

Next we come to the price structure of the economy. The unit value index of domestic exports is affected by the three factors introduced into the equation in different degrees. The estimated elasticities of this index with respect to these three factors are:

WMF (wage of labor)	0.134
PM (price of imports)	0.752
PC (price of consumer goods)	0.044

Thus the price of domestic exports is most sensitive to the price of imports which is consistent with the fact that there is high proportion of raw materials or semi-manufactured products imported from abroad as inputs by most industries.

As for the price level of the colony, the estimated structural equations of consumer price index and gross domestic product deflator can be jointly reduced into the following two expressions:

$$PC = 14.65 + 0.22\ PM + 0.00019\ M2 + 0.54\ PC_{-1}$$

$$P = 33.40 + 0.37\ PM + 0.00040\ M2 + 0.19\ PC_{-1}$$

Both short and long run elasticities of these two measures with respect to price of imports and money supply are computed as follows:

Variable	Factor	Short Run Elasticity	Long Run Elasticity
PC	PM	0.257	0.559
	M2	0.094	0.203
P	PM	0.396	0.493
	M2	0.181	0.217

These estimates suggest that the price level of the economy, no matter measured by consumer price index or gross domestic product deflator, though inelastic, is more sensitive to import price than to money supply.

TABLE 3.1

SHORT-RUN AND LONG-RUN NOMINAL INCOME ELASTICITY
OF TOTAL MONEY DEMAND AND ITS COMPONENTS

Variable	Short-Run	Long-Run
SDEP	0.287	1.705
TDEP	0.246	1.078
DDEP	0.507	1.414
CURR	0.074	1.762
M2	0.299	1.417

Finally we focus on the money sector. Table 3.1 shows the elasticities of the money demand and its components. It can be seen that the nominal income elasticity of savings deposits is larger than time deposits which can be reasoned as follows. The deposits variables used in the present model are only those with licensed banks, with those of deposit-taking companies (DTCs) excluded. The uprising importance of the latter in the money market in recent years can best be shown by the following figures:

Year	Deposits with Licensed Banks	Growth Rate	Deposits with DTCs	Growth Rate
1978	59,929($mn.)		10,447($mn.)	
1979	67,985	13.44%	24,495	134.47%
1980	84,490	24.28%	42,716	74.39%
1981	109,227	29.28%	60,479	41.58%

Since the DTCs cannot take deposits less than 50,000 dollars from each depositor, this lack of 'retail transaction' of the DTCs makes them hard to substitute for the licensed banks in the savings deposits market. However time deposits have shifted much from the licensed banks to the DTCs because of higher interest rate paid by the latter. Furthermore Hong Kong's emerging role as a financial centre leads to a high nominal income elasticity of demand deposits which is estimated to be 0.507 in the short run and 1.414 in the long run. On the whole, money is a luxury which has a nominal income elasticity 1.417 in the long run.

The richness of the quarterly macroeconometric model is only partly explored above. There remains much to be investigated through multiplier and policy analysis which will be performed and presented in chapter five.

FOOTNOTES FOR CHAPTER III

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2. M. Friedman, The Consumption Function, Princeton University Press, 1957.
3. A. Ando and F. Modigliani, 'The Life Cycle Hypothesis of Saving: Aggregate Implications and Taste,' American Economic Review, Vol. 53, March 1963, pp. 55-84.
4. L.R. Klein and A.S. Goldberger, An Econometric Model of the United States 1929-52, Amsterdam: North-Holland Publishing Co., 1955, p.10.
5. In each subsequent structural equation, the 'u' variables with subscripts stand for the disturbance terms associated with the equations.
6. See, for example, Census and Statistics Department, The 1980-81 Budget: Estimates of Gross Domestic Product 1966-78, Hong Kong: Government Printer, p.29, paragraph 122.
7. J. Witte, 'The Micro Foundations of the Social Investment Function,' Journal of Political Economy, Vol. 71, October 1963, pp. 441-56.
8. K.L. Wong, The Tourist Industry in Hong Kong - Its Significance to the Economic Development of Hong Kong, unpublished M. Phil. thesis, The Chinese University of Hong Kong, 1979, p.161.
9. The proof of the transformation can be obtained from R. Pindyck and D. Rubinfeld, Econometric Models and Economic Forecasts, New York: McGraw-Hill Book Co., 1981, pp. 232-33.

10. The inclusion of the lagged dependent variable in the consumption equation of macroeconometric models can be found in many studies of United States. See, for example, T.C. Lau, 'An Exploratory Quarterly Econometric Model of Effective Demand in the Postwar U.S. Economy,' Econometrica, Vol. 31, No. 3, July 1963, pp. 301-48.
11. K.L. Wong, ibid., p. 40.
12. L.R. Klein and A.S. Goldberger, ibid., p.20.
13. The detail can be seen from Census and Statistics Department, The 1980-81 Budget: Estimates of Gross Domestic Product 1966-78, Hong Kong: Government Printer, p. 25, paragraph 96.
14. K.L. Wong, ibid., p. 153.
15. See, for example, W.L. Chou, 'Inflation and Money Supply: The Case of Hong Kong,' Academia Economic Papers, Vol. 8, No. 1, March 1980, pp. 259-72, and Y.K. Ho, 'A Trivariate Stochastic Model for Examining the Cause of Inflation in a Small Open Economy - Hong Kong,' Economic Research Centre Working Papers, The Chinese University of Hong Kong, 1981. The former holds the view that inflation rate of the economy is principally a monetary phenomenon, while the latter has the opinion that inflation of the economy is an imported type.
16. The assumptions are (i) disturbance term has zero expected value; (ii) disturbance term has constant variance and not auto-correlated; (iii) number of observations are not less than the number of explanatory variables; and (iv) the explanatory variables are sets of non-stochastic numbers.
17. Consistency is a desired property of an estimator which means that by increasing the sample size, the estimator can be made to lie arbitrarily close to the true value of the parameter with probability arbitrarily close to one.

18. For the detail of the seemingly unrelated regression method, see G.G. Judge, W.E. Griffiths, R. Carter Hill and T.C. Lee, The Theory and Practice of Econometrics, Taiwan: Double Leaves Book Store Co.(Reprinted), 1980, p. 245.

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20. T.C. Lau and E.C. Hwa, 'A Monthly Econometric Model of the U.S. Economy,' International Economic Review, June 1974, pp. 328-65.

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CHAPTER IV

HISTORICAL SIMULATION AND FORECASTING

The theoretical motivation and the empirical results of the quarterly model has been presented in chapter III. The problem we are facing now is how to evaluate or test the goodness of the model. We have seen in the preceeding chapter that the significances of the estimated parameters can be judged by the associated t-values. However apart from this, nothing has been said about the goodness of the model in representing the real world phenomenon. In order to gain this end, the so-called 'ex post or historical simulation' is performed. By simulating the model during the sample period for which historical data for all variables are available, a comparison of the simulated series for each endogenous variable with the original data can be made to evaluate the goodness of the model. Measures such as the rms (root-mean-square) simulation error, the rms percent error for individual variables are used to evaluate the performance of a simulation model. Ex ante forecasts, which predict values of endogenous variables beyond the estimation period using exogenous variables that may or may not be known with certainty, are made after examining the performance of the simulation model. Alternative assumptions on future values of explanatory exogenous variables are made to take probable policy design and external disturbances into consideration.

4.1 Historical Simulation

The construction and analysis of historical simulation are to evaluate the model's ability to replicate the actual data. Before we simulate our model, it is necessary to distinguish two types of simulation.

It is noted in section 2.1 of chapter II that each macroeconometric model should be complete, that is, the number of structural equations should be matched with the number of endogenous variables. By assigning values to the pre-determined variables in each simulation period, the present model becomes a simultaneous equation system of 18 variables. Thus the values of endogenous variables can be uniquely determined. However among the pre-determined variables there are lagged endogenous variables and in each simulation period other than the initial one, actual as well as simulated values of the lagged endogenous variables will be both ready to be used. Thus ambigity in assigning values to these lagged endogenous variable resulted. If the actual values are used the simulation is called a static one, otherwise it is known as dynamic simulation. Often dynamic simulations are performed as they give the time paths of the variables generated by the model itself and is more helpful for the evaluation of the model.

Having clarified the meaning of a dynamic simulation of a model, a historical dynamic simulation is performed for our model. The simulation is a non-stochastic one and we have chosen a period of 10 quarters which starts from the third quarter of 1978 and ends at the fourth quarter of 1980. This is a fairly long period for testing the validity of the quarterly model. Table 4.1 presents the results of 15 major variables and their movements with respect to the actual figures are plotted in figures 4.1 to 4.15.

TABLE 4.1 SIMULATED VALUES OF 15 ENDOGENOUS VARIABLES*

Variable	1978.3	1978.4	1979.1	1979.2	1979.3	1979.4	1980.1	1980.2	1980.3	1980.4
CP	8,724	9,659	8,982	9,354	9,556	10,649	9,988	10,389	10,736	11,773
IPV	2,139	2,304	2,442	2,450	2,615	2,752	2,904	2,894	2,971	3,143
DEG	8,179	8,354	7,839	8,788	9,554	9,352	8,621	9,247	9,775	9,541
ES	2,680	2,964	2,665	3,067	2,910	3,181	2,838	3,149	3,173	3,541
MG	11,079	12,501	11,266	13,314	12,552	14,625	13,400	14,760	14,505	16,573
MS	1,418	1,501	1,550	1,611	1,671	1,764	1,828	1,893	1,975	2,082
GDP	12,954	13,411	12,677	14,038	14,391	15,156	14,355	15,132	15,951	16,759
PE	142	146	153	161	168	172	174	177	183	186
PC	126	129	133	138	144	149	153	157	162	167
P	137	140	145	151	158	163	166	170	176	181
SDEP	24,804	26,150	27,096	28,949	31,040	33,501	35,225	37,360	39,975	42,988
TDEP	24,010	25,209	26,230	28,376	30,727	33,363	35,139	37,141	38,963	41,533
DDEP	14,435	15,212	15,471	16,607	17,840	19,332	19,930	21,069	22,916	24,821
CURR	6,116	6,332	6,528	6,785	7,068	7,387	7,672	7,992	8,353	8,755
M2	69,276	72,902	75,324	80,717	86,074	93,583	97,967	103,562	110,208	118,097

*All variables are in their respective units defined in the model.

Figure 4.1 Historical Simulation on Private Consumption Expenditure

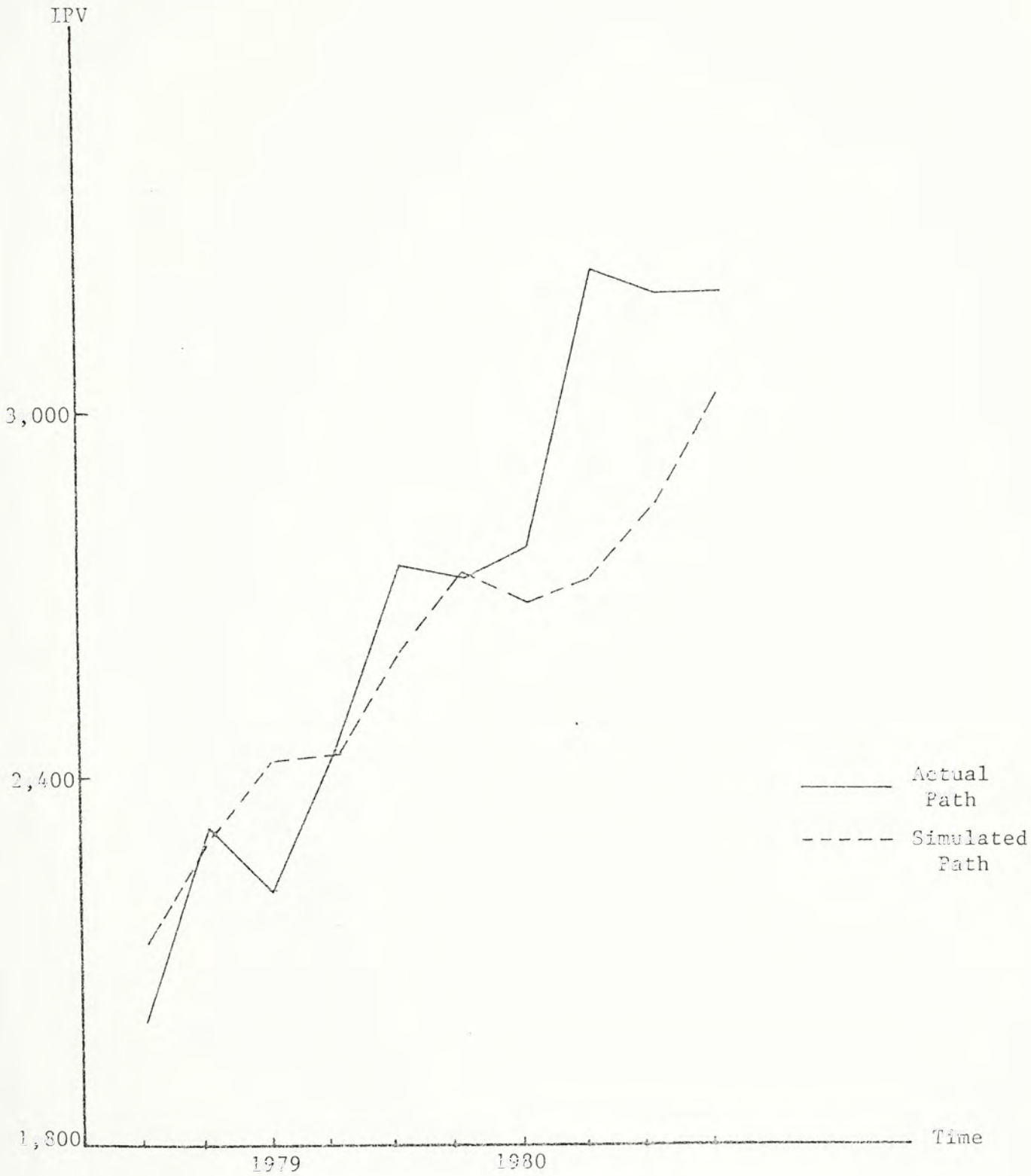

Figure 4.2 Historical Simulation on Gross Domestic Fixed Capital Formation

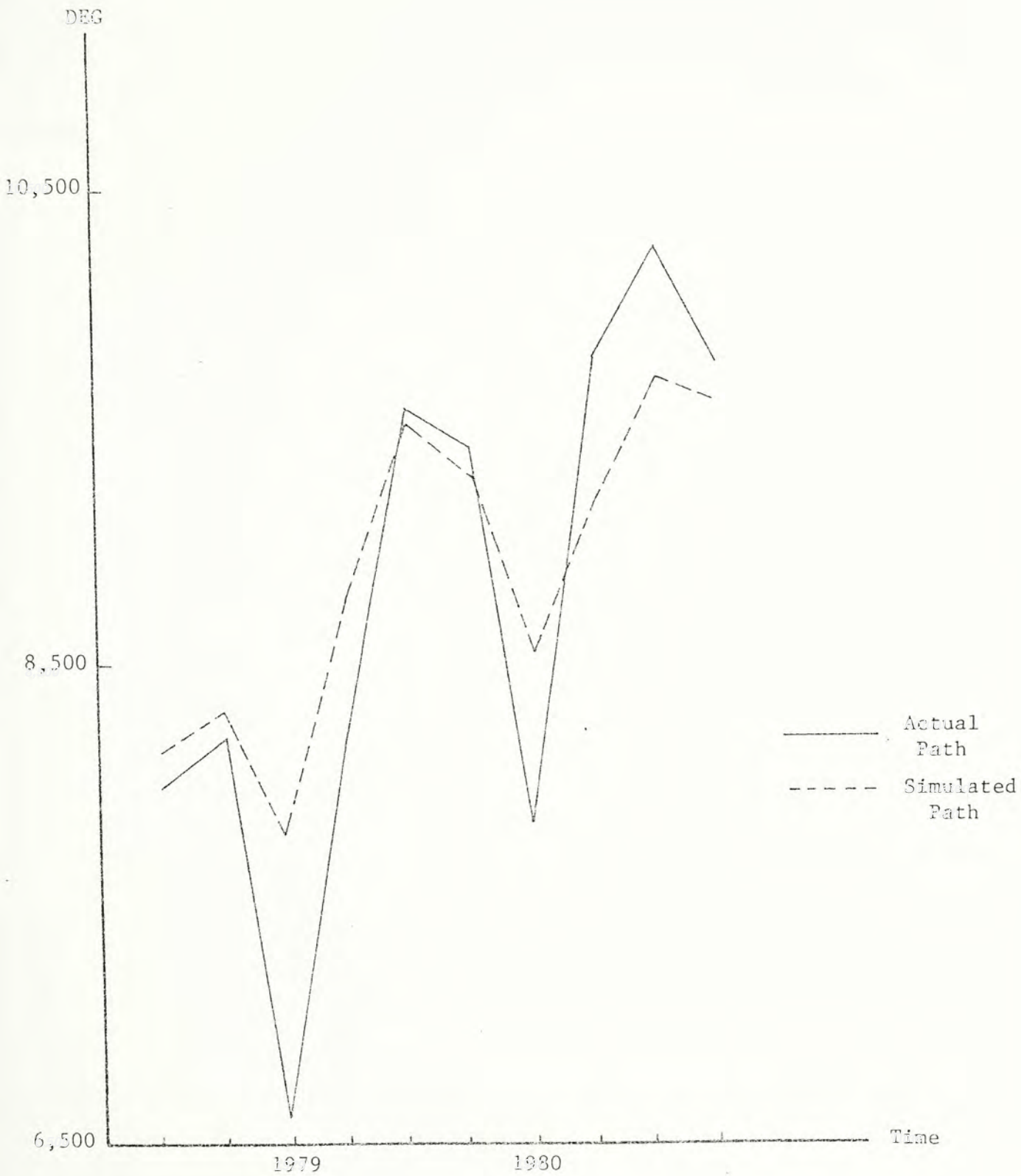

Figure 4.3 Historical Simulation on Domestic Exports of Goods

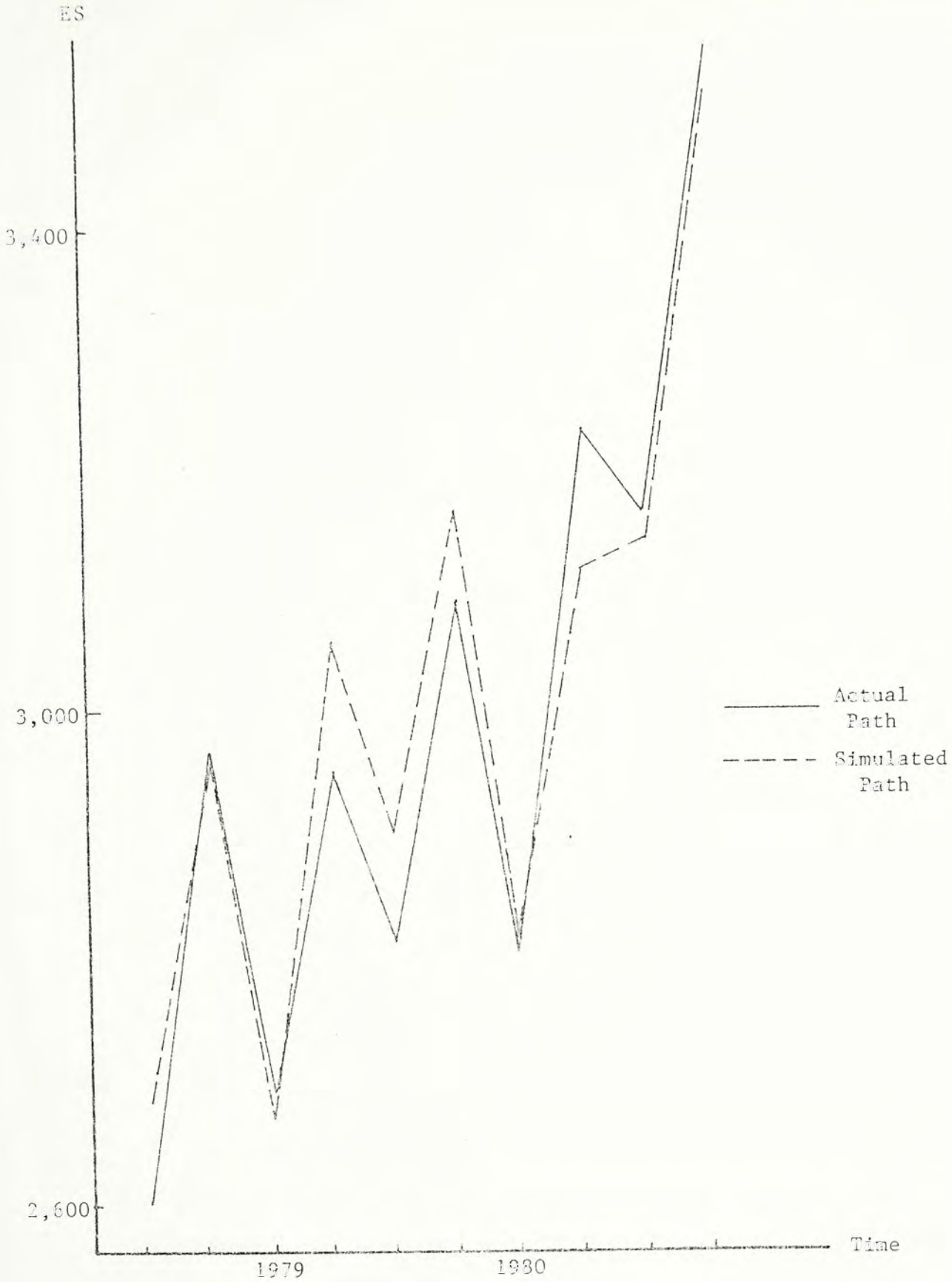

Figure 4.4 Historical Simulation on Exports of Services

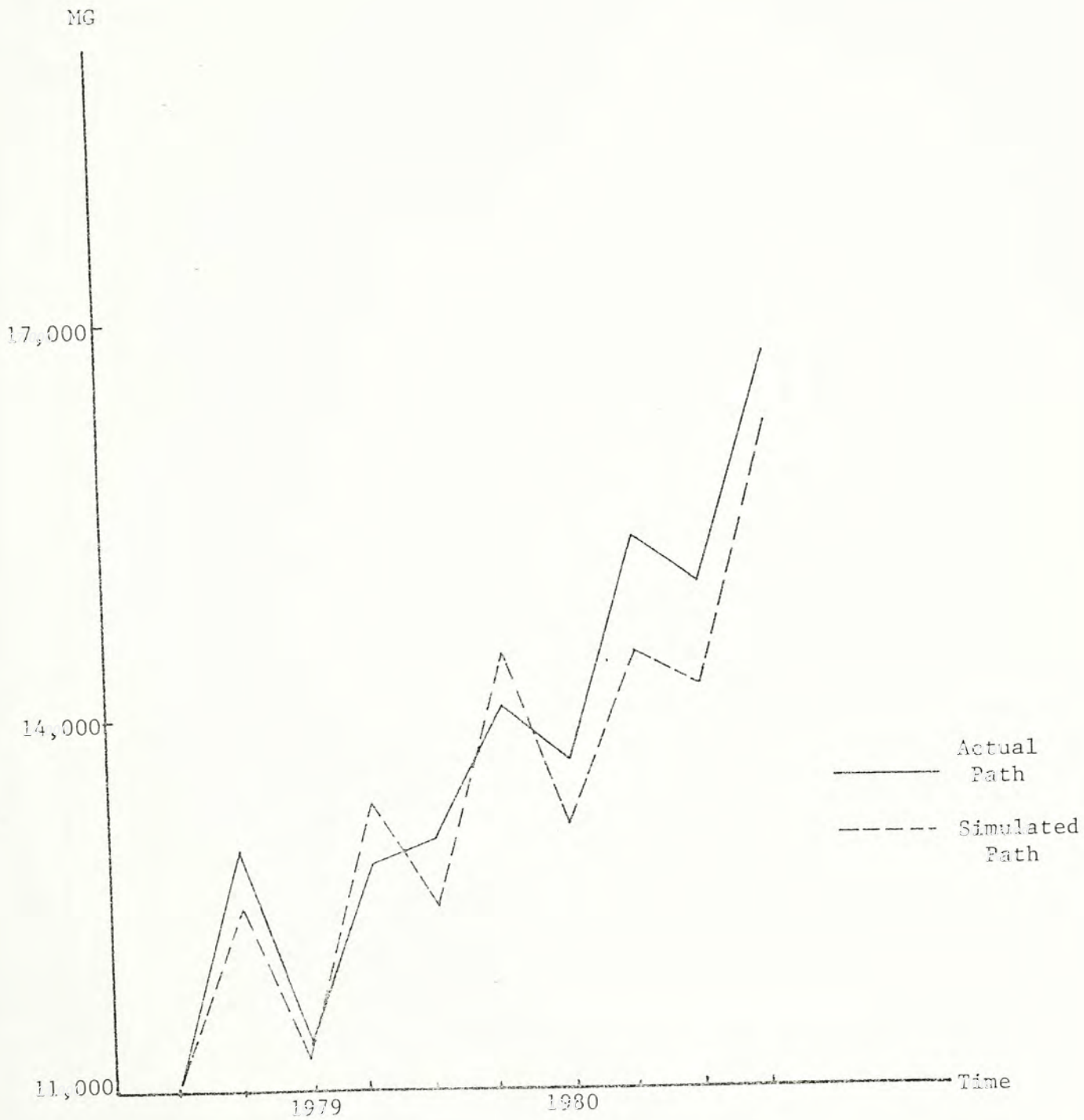

Figure 4.5 Historical Simulation on Imports of Merchandises

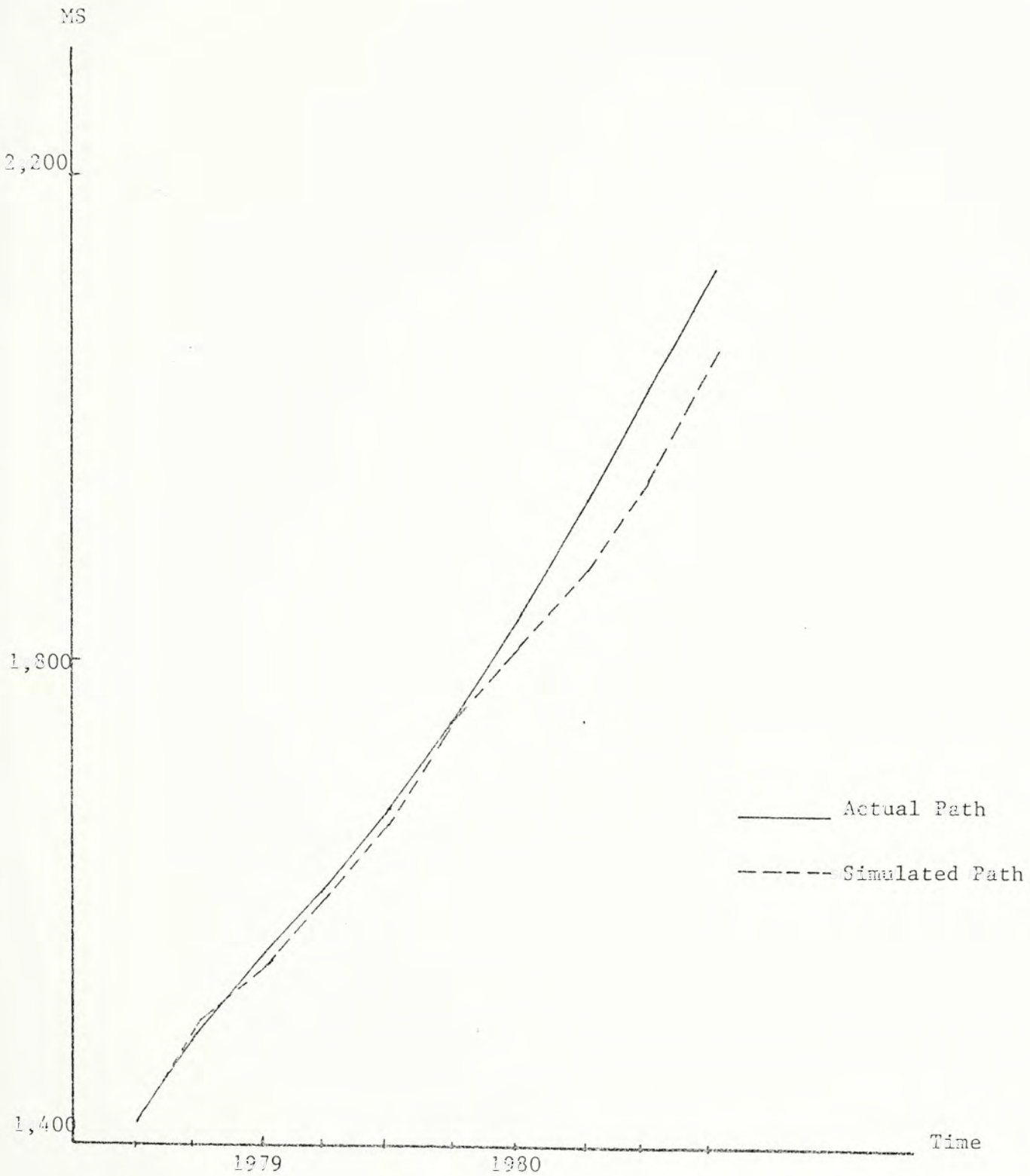

Figure 4.6 Historical Simulation on
Imports of Services

Figure 4.7 Historical Simulation on Gross Domestic Product

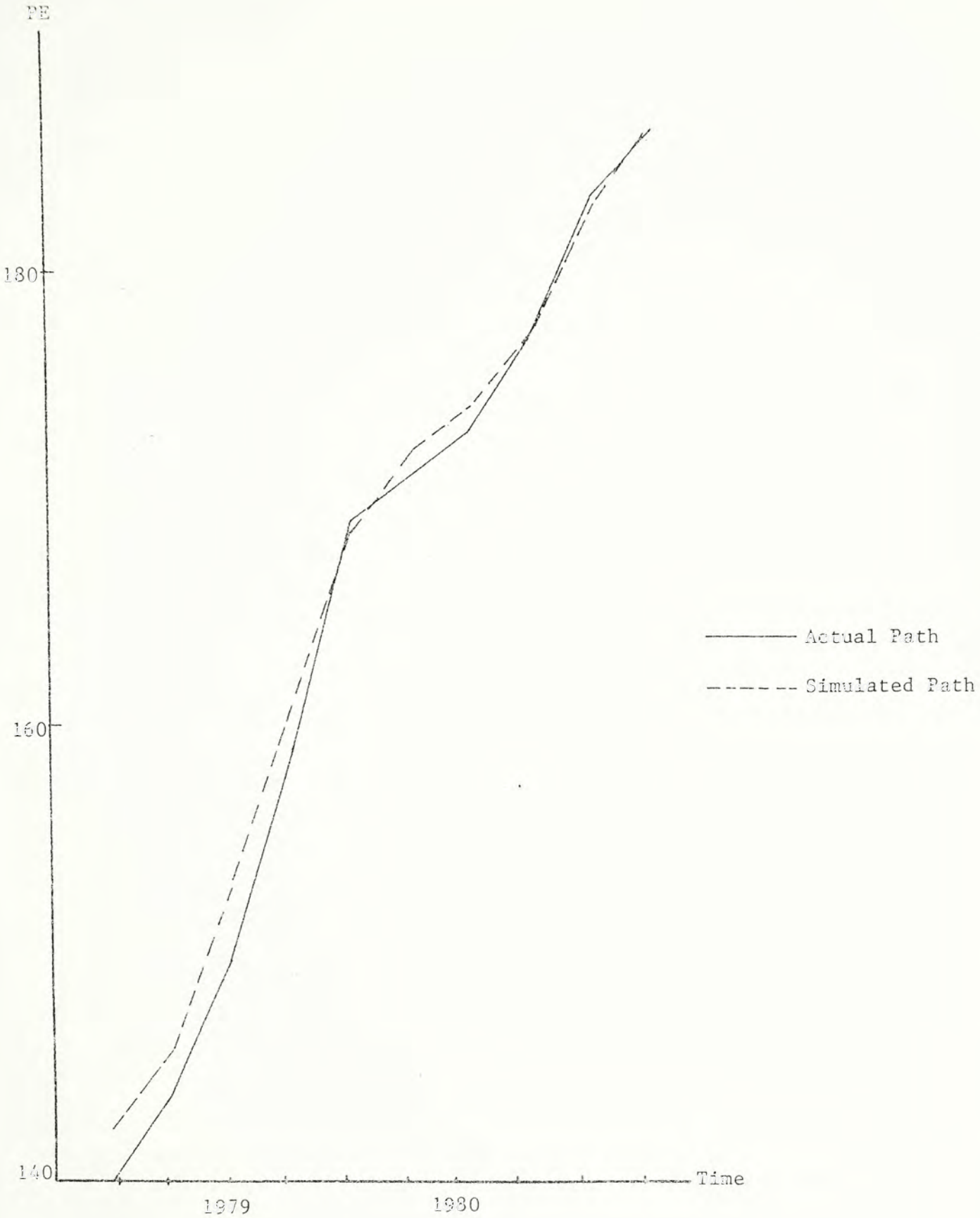

Figure 4.8 Historical Simulation on Unit Value Index of Domestic Exports

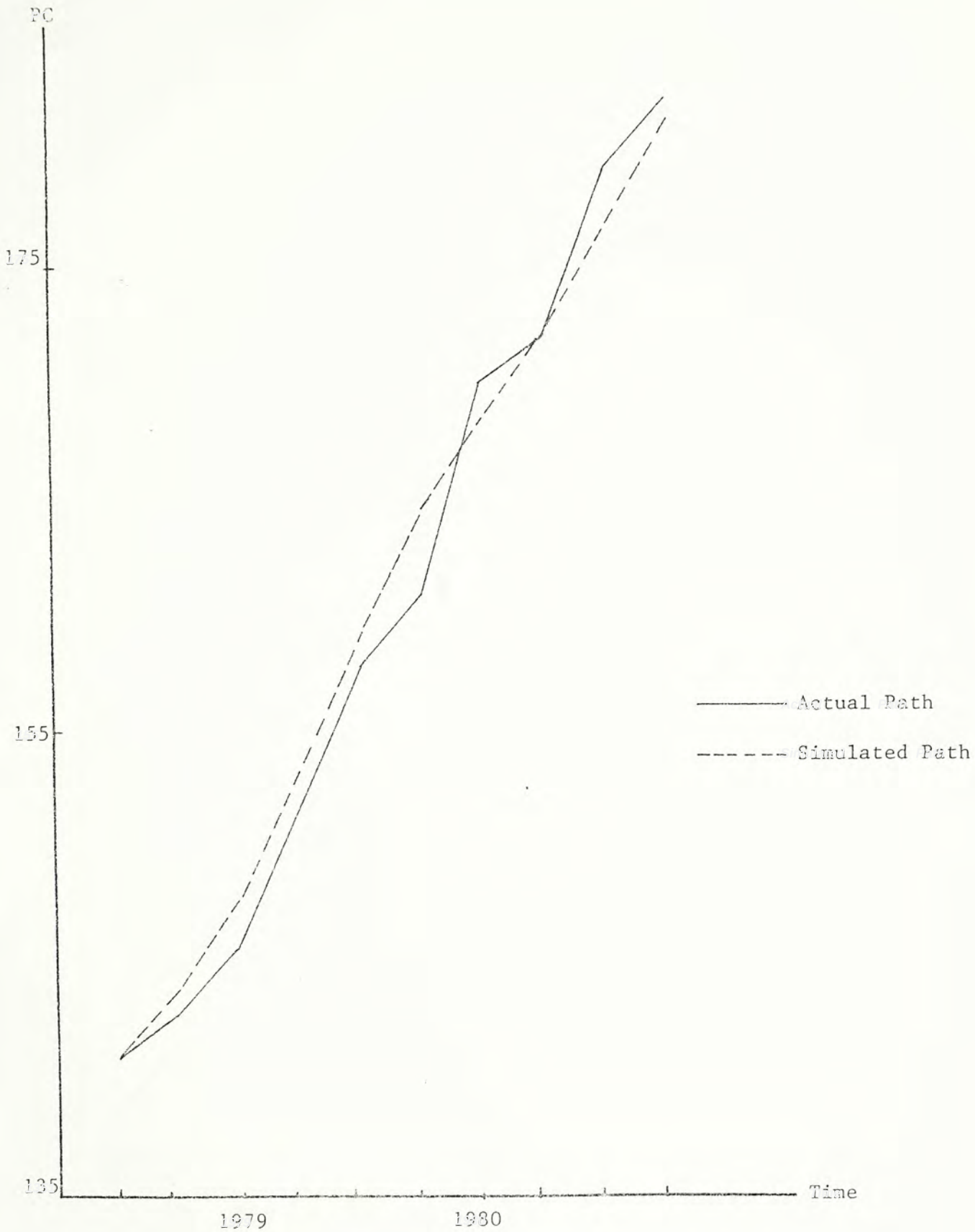

Figure 4.9 Historical Simulation on
Consumer Price Index (A)

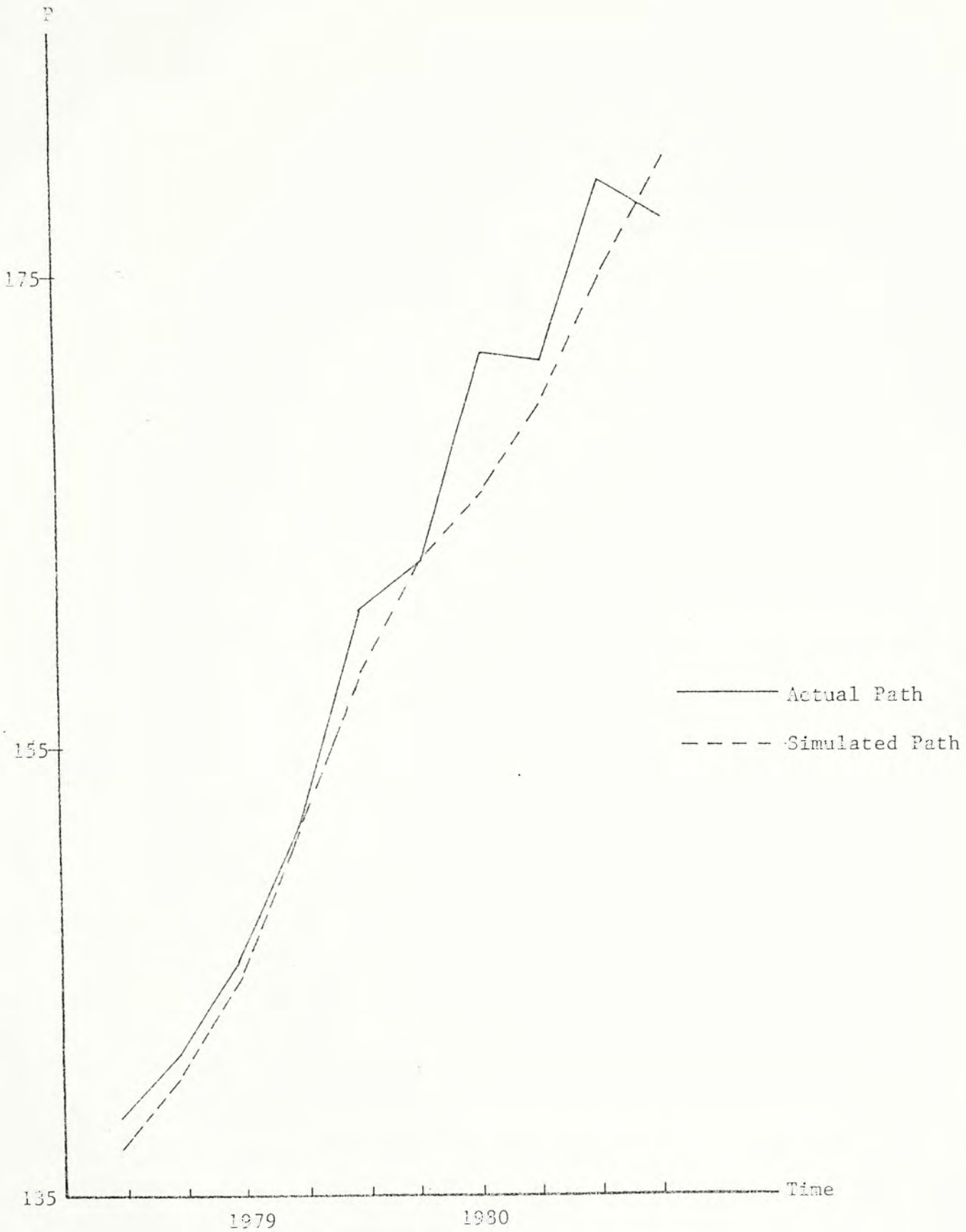

Figure 4.10 Historical Simulation on Gross Domestic Product Deflator

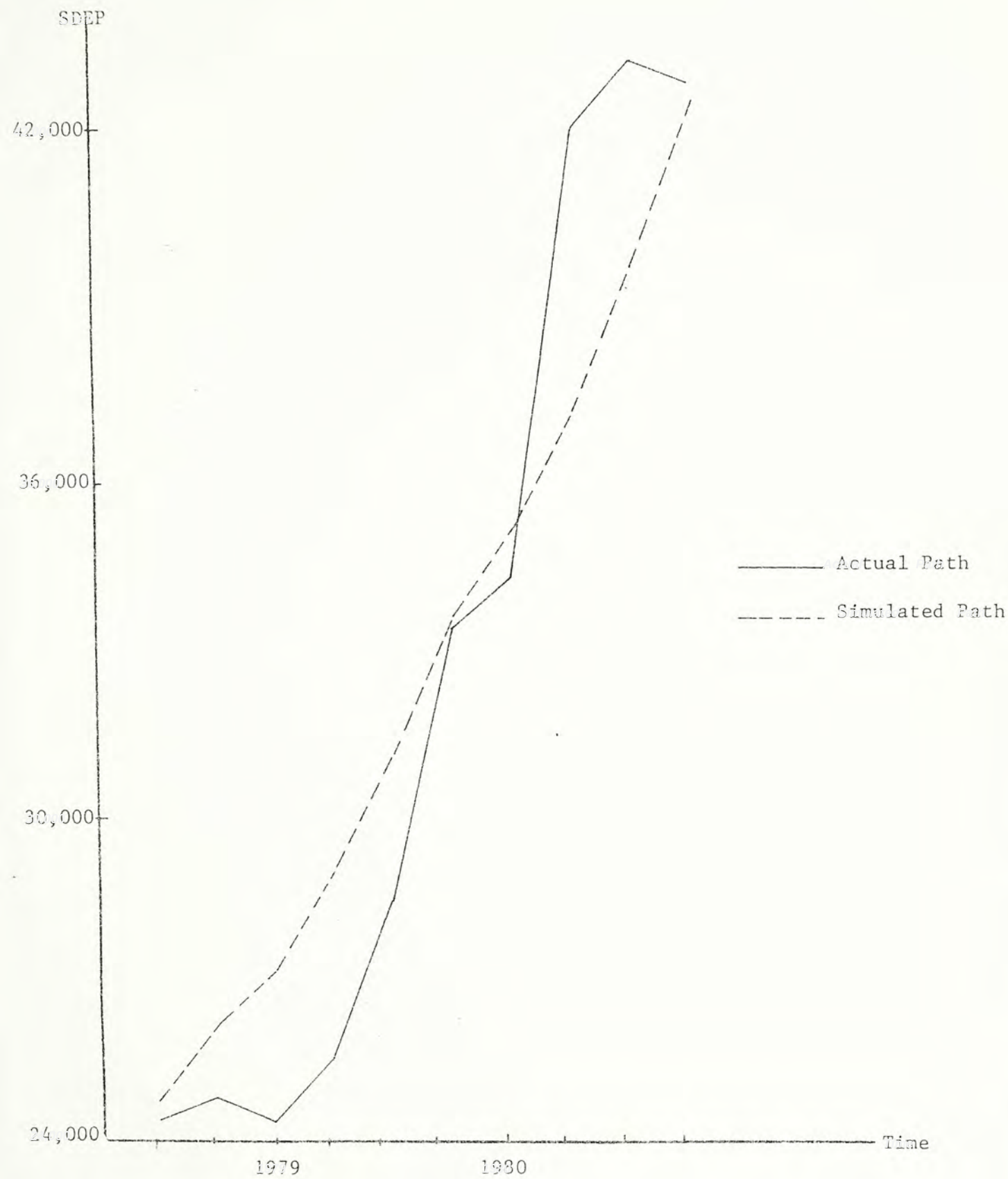

Figure 4.11 Historical Simulation on Savings Deposits with Licensed Banks

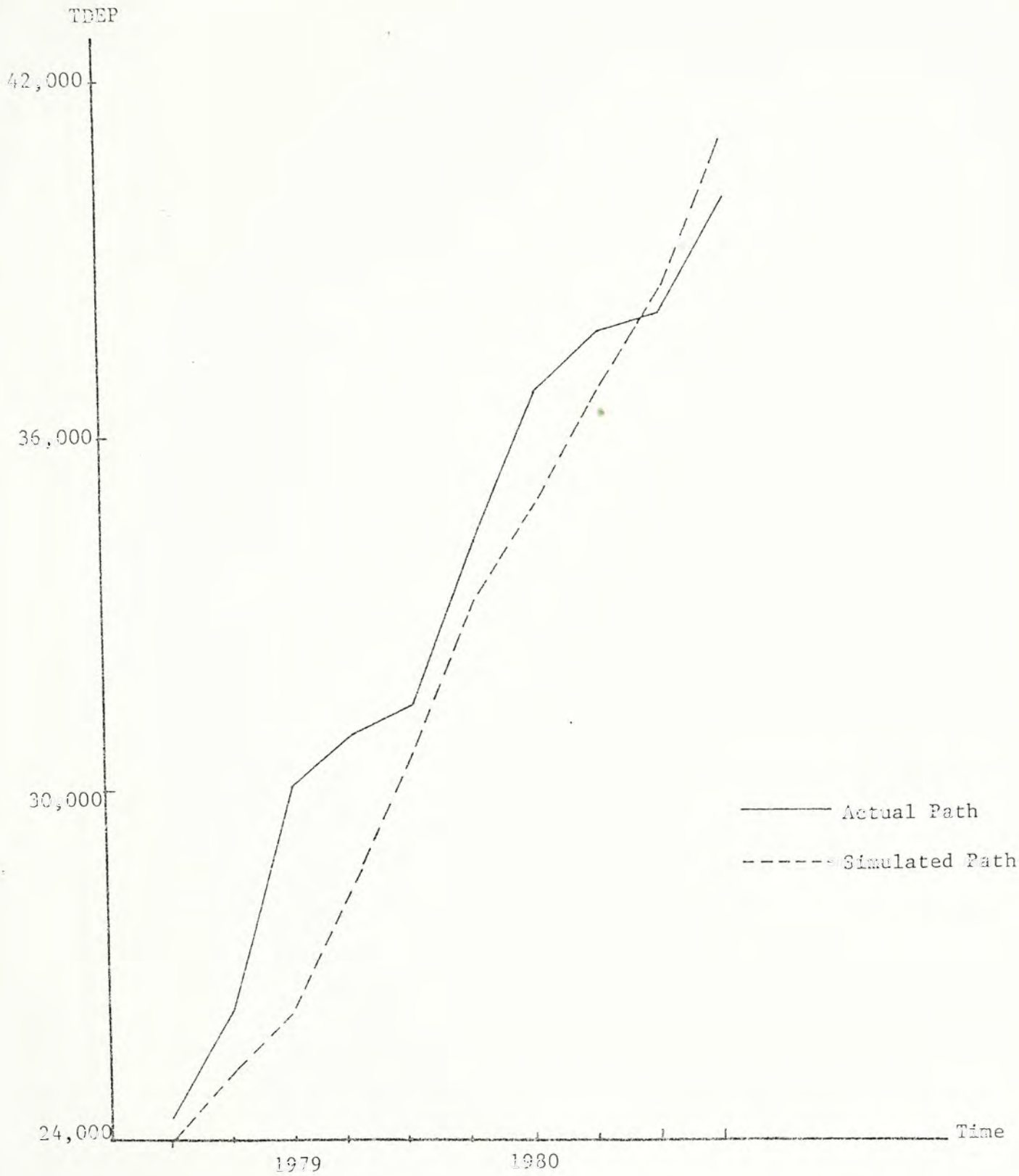

Figure 4.12 Historical Simulation on Time Deposits with Licensed Banks

Figure 4.13 Historical Simulation of Demand Deposits with Licensed Banks

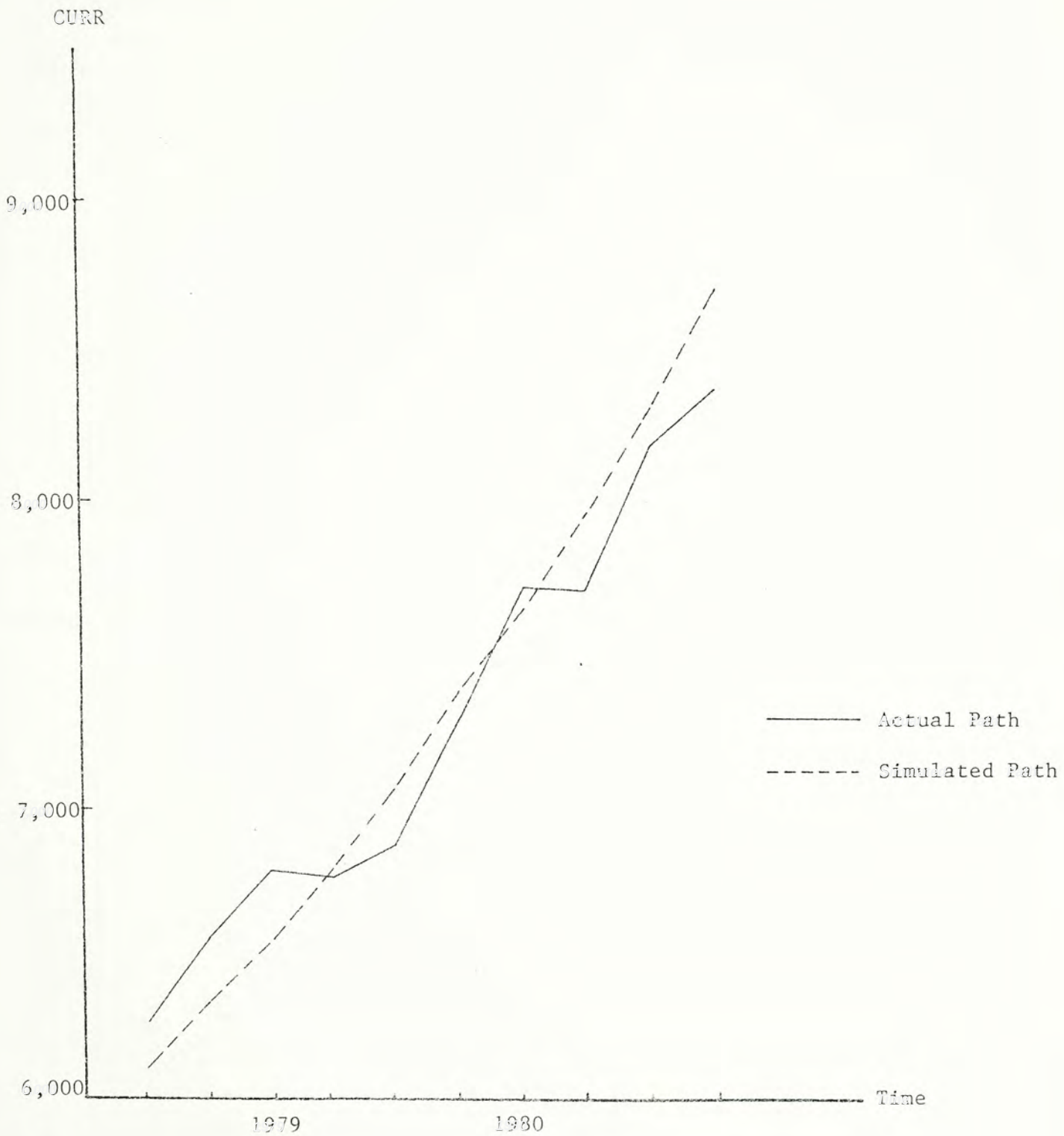

Figure 4.14 Historical Simulation on Currency in Circulation

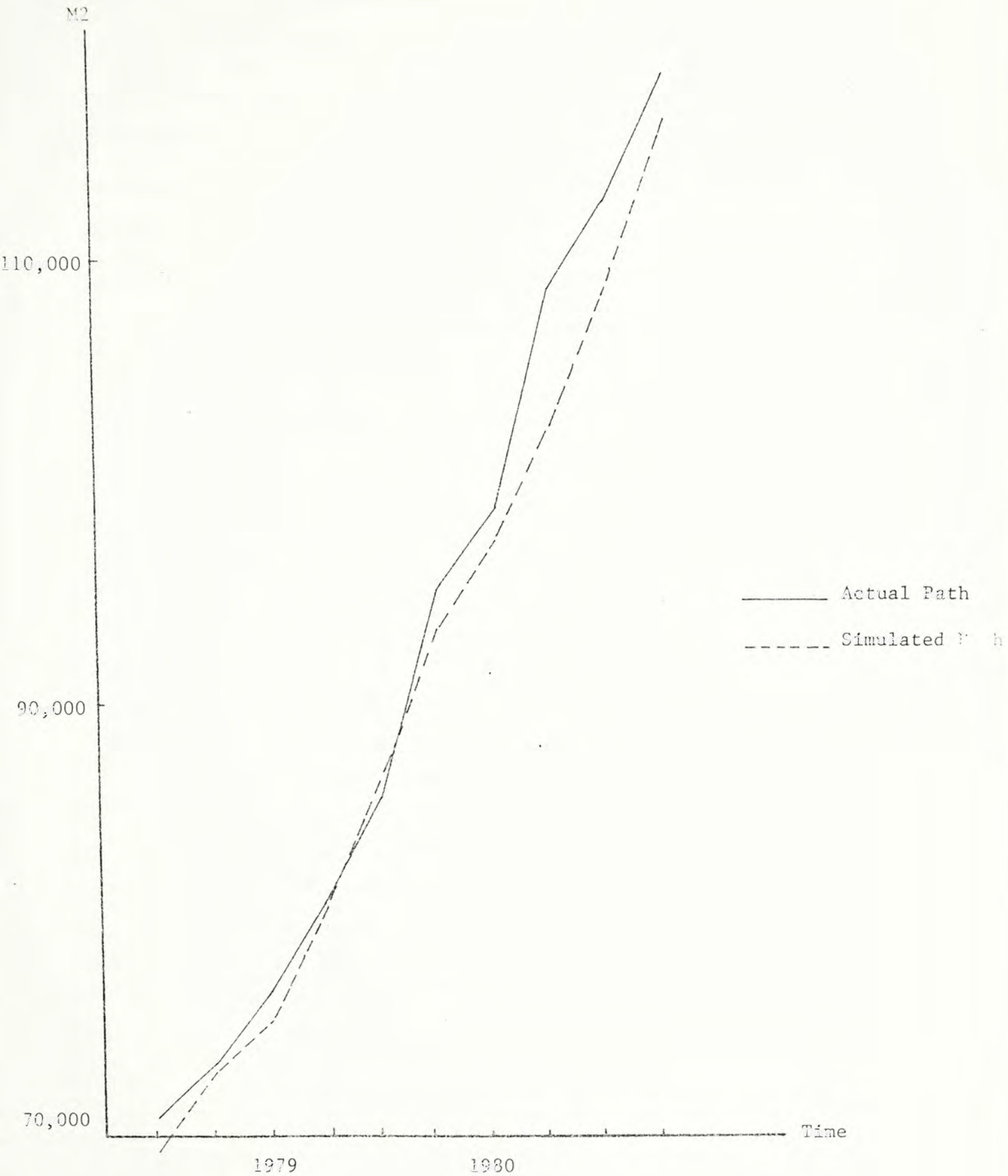

Figure 4.15 Historical Simulation on Money Supply (Definition 2)

Examination of these graphs leads to the conclusion that the simulated series of most of the endogenous variables seems to track the historical data well. majority of the turning points can be identified (with the exception of gross domestic fixed capital formation by private sector which is often proved to be unsuccessful in tracing its time path). For instance, the actual and the simulated time paths of the gross domestic product (GDP) in figure 4.7 moves synchronously over the ten quarters of simulation. However the overall performances of the model cannot be solely viewed from the discrepancies between the actual and the simulated paths of the variables because of the scaling factor of the graphs. Two measures are used to quantify these errors. They are the root-mean-square (rms) error and the rms percent error which are defined as:

$$\text{rms error} = \sqrt{\frac{1}{T}\sum_{1}^{T}(Y_t^s - Y_t^a)^2}$$

and

$$\text{rms percent error} = \sqrt{\frac{1}{T}\sum_{1}^{T}\left(\frac{Y_t^s - Y_t^a}{Y_t^a}\right)^2}$$

where Y_t^s = simulated values of variable Y in period t,

Y_t^a = actual value of variable Y in period t,

T = total number of time periods in the simulation.

The rms error measures the deviation of the simulated values from the actual path of the variable under investigation in absolute terms while the rms percent error is in percentage terms. The rms error should be evaluated by comparing with the average value of

the variables. Table 4.2 shows the rms error as well as the rms percent error of the 10-quarter dynamic simulation.

Based on the two measures devised above, the performance of the quarterly model in the historical simulation is quite satisfactory. Out of the 15 variables simulated, all are under 10 percentage points in terms of rms percent error, and four are over five percent error in terms of the ratio between the rms error and the sample mean, among which the savings deposits with licensed banks deviate the most.

Among the five sectors in the model, the price sector gives the best fit in this 10-quarter dynamic historical simulation. The rms percent error for all three endogenous variables in this sector is below two percent. On the other hand the performance of the historical simulations of the gross domestic product and its components are also satisfactory as most of them are less than 5 percent under the rms percent error measure. Furthermore majority of these components are able to identify the turning points within the simulation period. This is certainly of great importance when we are making forecasts for the variables beyond the estimation period.

4.2 Forecasts for 1981 and 1982

The general performance of the quarterly model in the historical past was quite satisfactory as can be seen from the simulated results obtained in the last section. This give us certain degree of confidence to make ex ante forecasts for the endogenous variables beyond the time period in which the model is estimated. By forecasting beyond the estimation period we mean to obtain the dynamic simulated results of the variables performed in the preceeding section by assigning new values to the exogenous variables over the forecasting period and the

TABLE 4.2

RMS ERROR AND RMS PERCENT ERROR
OF 10-QUARTER DYNAMIC SIMULATION
(1978.3 TO 1980.4)

Variable	RMS Error	Mean	RMS Error / Mean	RMS Percent Error
CP	430	10,184	4.22(%)	4.26(%)
IPV	164	2,691	6.09	5.90
DEG	547	8,775	6.23	7.38
MG	420	13,612	3.09	3.01
ES	68	2,987	2.28	2.33
MS	26	1,747	1.49	1.33
GDP	421	14,279	2.95	3.19
PE	1.6	165	0.97	1.09
PC	1.7	145	1.17	1.15
P	2.6	160	1.63	1.53
SDEP	2,471	32,294	7.65	7.80
TDEP	1,770	33,052	5.36	5.63
DDEP	799	19,405	4.12	4.45
CURR	210	7,247	2.90	2.82
M2	2,200	91,997	2.39	2.15

initial values to the lagged endogenous variables. If these values are known with certainty in advance, the forecasts we made will be called an unconditional one. Because the values of some exogenous variables are not known with certainty, so that forecasts for them must be used to produce ex ante forecasts for the endogenous variables, thus our forecasts made for the years 1981 and 1982 are so-called conditional forecasts. Furthermore the forecasting power of the model cannot be tested since actual data for the endogenous variables are not known in the forecast period.

Since the future values of the exogenous values are not known, we outline in the following the means of generating values of the exogenous variables in the forecast period:

(a) TAX - actual data are available for four quarters of 1981 and the annual total for the year 1982 is estimated to grow at 12 per cent by the ERC Model in 1981. Thus quarterly figures of 1982 are set by multiplying the corresponding quarterly values in 1981 by the factor 1.12.

(b) HSBPR - its values up to the first quarter of 1982 are known. However there are conflicting views on its values in the second half of the year which largely depend on the economic performance of the United States. Two cases are assumed: (i) the low case assumes 15.5 and 14.5 per cent for the second and the third quarter of 1982, (ii) the high case represents rapid declining to 14.0 and 12.0 in the said quarters.

(c) ER - actual data on the trade-weighted effective exchange rate index are available for 1981 and it is assumed to drop by 2.5 per cent in the year 1982. The quarterly

values for 1982 are obtained by multiplying 0.975 to the corresponding quarterly figures in 1981.

(d) PWE - data are available for 1981 and it is assumed to decrease by 0.5 per cent for four successive quarters of 1982 in view of the relatively stable prices of crude oil and raw materials.

(e) TOUR - figures are available up to the first quarter of 1982. There is a 7 per cent growth in the first quarter of 1982 compared with the first quarter of 1981. Two cases are assumed. The pessimistic case is represented by a 7 per cent growth (compared with the corresponding quarter in 1981) throughout the rest quarters of 1982. On the other hand, the mild recovery of United States which is anticipated in the second half of the year leads us to be optimistic on the growth of the number of incoming tourists which is represented by a 10 per cent growth over the remaining quarters of 1982 (compared with the corresponding quarter in 1981).

(f) REG - re-exports of goods has risen rapidly in the recent years because of the modernisation policy of the People's Republic of China since 1978.It grows at a relatively constant rate of 6 per cent per quarter in 1981, that is, an annual growth rate of 26 per cent. However as the entrepot trading base level has grown much larger, the pace of the growth rate will become slower and it is assumed to gain a 4.5 per cent per quarter growth (an annual growth rate of about 20 per cent) in 1982.

(g) PM - actual data for the unit value index of imports are available for the year 1981. As the price of crude oil is lowered because of excess of supply, the price of imports is expected to increase at a slower rate than in the year 1981. The rate of increase is taken to be one per cent per quarter, or approximately five per cent for the whole year.

(h) WMF - the nominal wage index of manufacturing workers has been increased by 16 per cent in the year 1981 and is expected to gain the same rate in 1982.

(i) R90 - similar to the best-lending rate 'HSBPR', actual data are known up to the first quarter of 1981. The pessimistic view assumes 14.0, 13.5 and 12.0 per cent in the subsequent three quarters of 1982 while the optimistic view assumes 13.5, 12.5 and 10.0 per cent respectively.

(j) CG - the annual preliminary official actual figures for 1981 and forecasts for 1982 have been released which show an increase of 25 and 7 per cent, respectively. The average quarterly share for the estimation period is then used as weights to obtain the forecast values of the quarterly values in these two years.

(k) IG - the annual rate of increase in 1981 and 1982 estimated by government are 14 and 22 per cent respectively. The quarterly values for 1981 and 1982 are computed similarly as the variable CG where the average quarterly shares of the present variable are 0.29, 0.21, 0.24 and 0.26.

(l) CS - the annual figures for the years 1981 and 1982 are available. The technique applied to disaggregate IG and CG is not suitable here because of the randomness character of this variable appearing in the estimation period. Instead we use a weighted quarterly average method, which assigns heavier weight to the more recent observations, to calculate the quarterly shares.

(m) USAGNP - the quarterly gross national product (adjusted at annual rates) of United States is known for 1981. As for the year 1982, different opinions exist which can be broadly divided into two groups. The pessimistic opinion predicts that only mild recovery will happen at the end of the year and there will be hardly any growth in the year. On the contrary optimists hold the view that the growth rate for the first quarter will be one per cent and the moderate recovery expected in the second half of the year will result in a six per cent annual growth rate in gross national product by the fourth quarter.

Based on the above assumption, we simulate the model over the eight quarters of 1981 and 1982. The results are exhibited in Tables 4.3, 4.4 and 4.5.

The forecasts made for the successive quarters of 1981 and 1982 enable us to suggest the performance of the economy in the near future. If the recovery of the United States economy comes somewhat later than that expected by the optimists, the growth rate of the economy in the gross domestic product will be eroded from somewhat higher than 8 per cent at the beginning of 1982 to 6.8 per cent in the fourth quarter of the year. This is because the exports of the domestically produced

TABLE 4.3 THE FORECASTS OF THE ENDOGENOUS VARIABLES IN 1981

	1981.1		1981.2		1981.3		1981.4	
Variable	Forecast	Growth Rate (%)	Forecast	Growth Rate (%)	Forecast	Growth Rate (%)	Forecast	Growth Rate (%)
CP	10,991	(10.00)	11,582	(11.48)	12,045	(12.19)	12,967	(10.14)
C	12,158	(11.61)	12,616	(12.29)	13,165	(13.28)	14,150	(11.02)
IPV	3,321	(14.36)	3,398	(17.42)	3,487	(17.37)	3,650	(16.13)
CF	4,363	(13.00)	4,153	(16.82)	4,350	(14.93)	4,584	(18.48)
DEC	9,027	(4.71)	9,756	(5.50)	10,335	(5.73)	10,043	(5.26)
EC	13,992	(15.86)	14,919	(12.37)	15,730	(11.93)	15,672	(9.54)
ES	3,126	(10.15)	3,515	(11.62)	3,600	(13.46)	3,790	(7.03)
MC	15,695	(17.15)	16,809	(13.88)	16,707	(15.18)	18,125	(9.36)
MS	2,161	(18.21)	2,221	(17.33)	2,312	(17.06)	2,412	(15.85)
GDP	16,304	(13.58)	16,825	(11.19)	17,746	(11.25)	18,057	(7.75)
PE	191	(9.77)	197	(11.30)	204	(11.48)	210	(12.90)
PC	171	(11.76)	176	(12.10)	183	(12.96)	189	(13.17)
P	185	(11.45)	191	(12.35)	199	(13.07)	206	(13.81)
SDEP	45,321	(28.66)	48,138	(28.85)	51,608	(29.10)	55,221	(28.46)
TDEP	43,102	(22.66)	46,157	(24.28)	49,715	(27.60)	53,266	(28.25)
DDEP	25,736	(29.13)	27,040	(28.34)	29,008	(26.58)	30,988	(24.85)
CURR	8,772	(14.34)	9,203	(15.15)	9,690	(16.01)	10,205	(16.56)
M2	122,931	(25.48)	130,539	(26.05)	140,021	(27.05)	149,680	(26.74)

TABLE 4.4 THE PESSIMISTIC FORECASTS OF THE ENDOGENOUS VARIABLES IN 1982

	1982.1		1982.2		1982.3		1982.4	
Variable	Forecast	Growth Rate (%)	Forecast	Growth Rate (%)	Forecast	Growth Rate (%)	Forecast	Growth Rate (%)
CP	12,227	(11.25)	12,798	(10.50)	13,256	(10.05)	14,027	(8.17)
C	13,480	(10.87)	13,907	(10.23)	14,461	(9.84)	15,280	(7.99)
IPV	3,786	(14.00)	3,811	(12.15)	3,877	(11.18)	4,031	(10.44)
CF	5.062	(16.02)	4,735	(14.01)	4,933	(13.40)	5,175	(12.89)
DEG	9.249	(2.46)	9,911	(1.59)	10,475	(1.35)	10,240	(1.96)
EG	15,103	(7.94)	15,999	(7.24)	16,807	(6.85)	16,825	(7.36)
ES	3.303	(5.66)	3,702	(5.32)	3,771	(4.75)	4,013	(5.88)
MG	17,366	(10.65)	18,371	(9.29)	18,281	(9.42)	19,679	(8.57)
MS	2,483	(14.90)	2,542	(14.45)	2,626	(13.58)	2,719	(12.73)
GDP	17,611	(8.02)	18,064	(7.36)	18,998	(7.06)	19,285	(6.80)
PE	213	(11.52)	216	(9.64)	220	(7.84)	224	(6.67)
PC	195	(14.03)	200	(13.64)	205	(12.02)	210	(11.11)
P	211	(14.05)	216	(13.09)	222	(11.56)	227	(10.19)
SDEP	58,203	(28.42)	61,360	(27.47)	65,137	(26.21)	68,891	(24.76)
TDEP	55,983	(29.88)	58,636	(27.04)	61,605	(23.92)	64,309	(20.73)
DDEP	32,236	(25.26)	33,791	(24.97)	36,080	(24.38)	38,273	(23.51)
CURR	10,697	(21.94)	11,215	(21.86)	11,788	(21.65)	12,378	(21.29)
M2	157,121	(27.81)	165,002	(26.40)	174,609	(24.70)	183,852	(22.83)

TABLE 4.5 THE OPTIMISTIC FORECASTS OF THE ENDOGENOUS VARIABLES IN 1982

	1982.1		1982.2		1982.3		1982.4	
Variable	Forecast	Growth Rate (%)	Forecast	Growth Rate (%)	Forecast	Growth Rate (%)	Forecast	Growth Rate (%)
CP	12,227	(11.25)	12,825	(10.73)	13,334	(10.70)	14,210	(9.59)
C	13,480	(10.87)	13,934	(10.45)	14,539	(10.44)	15,463	(9.28)
IPV	3,786	(14.00)	3,814	(12.24)	3,933	(12.79)	4,108	(12.55)
CF	5,062	(16.02)	4,738	(14.09)	4,989	(14.69)	5,252	(14.57)
DEG	9,249	(2.46)	10,071	(3.23)	10,936	(5.82)	11,304	(12.56)
EG	15,103	(7.94)	16,159	(8.31)	17,268	(9.78)	17,889	(14.15)
ES	3,303	(5.66)	3,775	(7.40)	3,889	(8.03)	4,216	(11.24)
MG	17,366	(10.65)	18,511	(10.13)	18,661	(11.70)	20,489	(13.04)
MS	2,483	(14.90)	2,550	(14.81)	2,649	(14.58)	2,776	(15.09)
GDP	17,611	(8.02)	18,179	(8.05)	19,307	(8.80)	19,947	(10.47)
PE	213	(11.52)	216	(9.64)	220	(7.84)	224	(6.67)
PC	195	(14.04)	200	(13.64)	205	(12.02)	210	(11.11)
P	211	(14.05)	216	(13.09)	222	(11.56)	228	(10.68)
SDEP	58,203	(28.42)	61,458	(27.67)	65,502	(26.92)	69,826	(26.45)
TDEP	55,983	(29.88)	58,645	(27.06)	61,712	(24.13)	64,653	(21.38)
DDEP	32,236	(25.26)	33,932	(25.49)	36,544	(25.98)	39,386	(27.10)
CURR	10,697	(21.94)	11,222	(21.94)	11,813	(21.91)	12,443	(21.93)
M2	157,121	(27.81)	165,257	(26.60)	175,571	(25.39)	186,308	(24.47)

goods will only increase by about two per cent for the year 1982. The growth rate of private consumption expenditure will also be lowered from 11.25 per cent to 8.17 per cent which has a cooling effect to the economy so that inflation rate is expected to decline from 14 per cent initially to an ultimate rate of 11 per cent in the fourth quarter, where the inflation rate is measured by the rate of change of consumer price index. The same also holds for the gross domestic product deflator which is forecast to rise at a rate of 10 per cent by the end of 1982. The visible trade deficit will be widened as the growth rate of imports of goods still exceeds that of merchandises exports. The money supply (M2) will grow at a slower pace in the second half of 1982 which will exert damping effect on inflation rate. This is revealed by the deceleration of the inflation rate at the second half of the forecast year.

Turning to the more optimistic forecasts, the recovery of the United States economy in the second half of the year leads to a great leap in the domestic exports and hence the gross domestic product of the economy. Their respective growth rates at the end of the forecast year are 12.6 and 10.5 per cent. However the trade deficits are further widened until the third quarter of 1982 and begin to narrow in the fourth quarter when the growth rate of exports of merchandises is 14.15 per cent and that for the imports of goods is 13.04 per cent. For the invisible trade, negative growth rates persist until the fourth quarter of 1982 in which the net exports of services are forecast to grow at a rate of 4.5 per cent. The inflationary pressure to the economy is also eased because of the relatively stable imports price and the smaller growth rate of money supply.

CHAPTER V

MULTIPLIERS AND POLICY ANALYSIS

The forecasts made in the last chapter are based on certain assumptions which have been stated clearly there. Suppose now the government tightens its expenditure, what will then be the effects of the policy on the economy? We can see from the estimated structural model in section 3.4 of chapter III that the direct impact will be a contraction of the gross domestic product through the reduction in the final demand. However the effect will spread over as the gross domestic product of the economy affects many other endogenous variables in the model and that interactions between these variables change the economy very much consequently. The final outcomes can only be obtained by tedious substitutions. This appears to be the shortcoming of the structural form of a macroeconometric model where only the economic mechanism of the direct determinants of the endogenous variables are depicted.

To tackle this kind of problems, reduced form of a macroeconometric model is preferred to be used which is obtained by solving the system with respect to the endogenous variables, that is, by expressing the endogenous variables in terms of the pre-determined variables. The coefficients associated with the exogenous variables in this reduced form measure the immediate effects of the changes in the exogenous variables on the endogenous variables and are called the impact multipliers. However the existence of lagged endogenous variables in the model makes

it possible for the transmission of these immediate impacts to the later periods and these responses are called the dynamic multipliers. For stable systems these dynamic multipliers will become smaller in magnitude the greater the lag in the variable with which they are associated. Finally the sum of all dynamic multipliers attached to a particular endogenous variable is called the cumulative or total multiplier of that variable. All of these can be derived once the reduced form of the model is obtained.

5.1 Reduced Form and Final Form of the Model

The reduced form of a macroeconometric model is more convenient than the structural form in the calculation of the effects of changes in exogenous variables on the behaviour of endogenous variables. However the non-linearity of the present model introduces some degree of complexity in the computation of the reduced form. To illustrate its derivation, we first start with a simpler case in which the system is a linear one.

Suppose we have an estimated linear system of g endogenous variables y_i's ($i = 1,2,\ldots,g$) and k pre-determined variables x_j's ($j = 1,2,\ldots,k$) in which the disturbances are put at their zero expected levels. The system can then be expressed in the familiar matrix notation:

$$A X + B Y = 0 \qquad (5.1)$$

where A is a g x k matrix on the estimated structural parameters of the k pre-determined variables,

X is a k x 1 column vector of the k pre-determined variables,

B is a matrix of order g x g on the estimated structural parameters and is assumed to be non-singular,

Y is a g x 1 column vector of the g endogenous variables.

From equation (5.1) the reduced form of the linear system can be expressed as:

$$Y = -B^{-1}A\,X \qquad (5.2)$$

$$= W\,X \qquad (5.3)$$

where $W = (-B^{-1}A)$ is the matrix of reduced coefficients which are expressed in terms of the structural coefficients. It can immediately be seen that $\partial y_i/\partial x_j$ is equal to w_{ij}, the $(i,j)^{th}$ entry of the matrix W. Thus the reduced form coefficients measure the magnitudes of current period changes of the endogenous variables inducing by a unit change of an exogenous variable in a particular period, keeping all other exogenous variables at constant levels. Hence the coefficients of the reduced form matrix correspond to the impact multipliers of the exogenous variables.

Turning now to a non-linear system which can be written as:

$$F(x,y) = 0 \qquad (5.4)$$

where F is the matrix of functional operators on the estimated structural parameters,

x is the set of k pre-determined variables,

y is the set of g endogenous variables.

Taking total differential of F we have:

$$0 = dF$$

$$= (\partial F/\partial x)dx + (\partial F/\partial y)dy \qquad (5.5)$$

and thus

$$dy = -(\partial F/\partial y)^{-1}(\partial F/\partial x)dx$$

$$= \Pi\, dx \qquad (5.6)$$

where $\Pi = -(\partial F/\partial y)^{-1}(\partial F/\partial x)$.

When these partial derivatives are evaluated at some particular values of x and y, say x_o and y_o, we then have a linearised reduced form of the non-linear model given by:

$$dy = \Pi_o dx \qquad (5.7)$$

where

$$\Pi_o = \Pi \Big|_{\substack{x = x_o \\ y = y_o}}$$

$$= -(\partial F/\partial y)^{-1}\Big|_{\substack{x = x_o \\ y = y_o}} (\partial F/\partial x)\Big|_{\substack{x = x_o \\ y = y_o}}$$

Similar to the case of a linear system, the $(i,j)^{th}$ entry of the matrix Π_o measures the immediate change of the i^{th} endogenous variable induces by a unit increase in the j^{th} exogenous variable, keeping all other exogenous variables constant. These impact multipliers clearly depend on the values x_o and y_o chosen for the computation of the partial derivatives. When they are chosen as the sample means of the variables in the estimation period, the resultant reduced form coefficients can be interpreted as average values of the impact multipliers.

For the present model, 9 out of the 18 structural equations involve non-linearities. The partial derivatives are linearised by the above method about the sample means of variables so that a linearised system

in terms of the changes of variables like that in equation (5.5) is obtained, then the inversion and multiplication of matrices lead to a linearised reduced form of the non-linear quarterly model which is exhibited in the Appendix at the end of the thesis.

The reduced form of the model summarises all direct and indirect effects of changes of exogenous variables. However this makes it possible to account for the immediate responses only. The existence of lagged endogenous variables suggests that there will be lag responses and we have to go beyond the initial impacts in order to trace the dynamic responses. This is extremely important in the evaluation of economic policies.

To explore the dynamic responses, it is useful to derive the final form of the model. This final form of the equation system shows how the paths of the exogenous variables determine the time path of each endogenous variable. Recall that there are 18 endogenous variables, 16 exogenous variables and no variable with lags of three periods or more, the linearised estimated reduced form can be written as:

$$Y_t = \Pi_1 Y_{t-1} + \Pi_2 X_t + \Pi_3 X_{t-1} \qquad (5.8)$$

where Y_t is a 19 x 1 column vector of endogenous variables in period t,[1]

Y_{t-1} is a 19 x 1 column vector of one-quarter lagged endogenous variables in period t,

Π_1 is a 19 x 19 square matrix, made up by columns of estimated reduced form coefficients corresponding to respective one-quarter lagged endogenous variables,

X_t is a 16 x 1 column vector of exogenous variables in period t,

Π_2 is a 19 x 16 matrix made up by columns of estimated reduced form coefficients corresponding to respective exogenous variables,

X_{t-1} is a 16 x 1 column vector of one-quarter lagged exogenous variables in period t,

Π_3 is a 19 x 16 matrix made up by columns of estimated reduced form coefficients corresponding to respective one-quarter lagged exogenous variables.

Whenever the lagged variables do not occur in the model, the corresponding columns of the estimated reduced form coefficients will be zero. For instance, two out of the 16 columns of Π_3 are non-zero because there are only two lagged exogenous variables (PM_{-1} and $HSBPR_{-1}$) in the model.

The elements of Π_2 in equation (5.8) are the immediate influences of exogenous variables on the endogenous variables in the current quarter, however it will be incorrect to conclude that $\Pi_3$measures the impacts of the exogenous variables one quarter later. The reason is that X_{t-1} not only affects Y_t directly, but also indirectly through Y_{t-1}. To obtain the full effect of X_{t-1} on Y_t, we eliminate Y_{t-1} in equation (5.8) by lagging the equation by one quarter:

$$\begin{aligned} Y_t &= \Pi_1(\Pi_1 Y_{t-2} + \Pi_2 X_{t-1} + \Pi_3 X_{t-2}) + \Pi_2 X_t + \Pi_3 X_{t-1} \\ &= \Pi_1^2 Y_{t-2} + \Pi_2 X_t + (\Pi_1\Pi_2 + \Pi_3)X_{t-1} + \Pi_1\Pi_3 X_{t-2} \end{aligned} \qquad (5.9)$$

This shows that the total effect of changes of exogenous variables on the endogenous variables one quarter later is given by the matrix

$(\Pi_1\Pi_2 + \Pi_3)$. Proceeding similarly we can find out the influences of X_{t-s} on Y_t:

$$\begin{aligned} Y_t = {} & \Pi_1^{s+1} Y_{t-s-1} + \Pi_2 X_t + (\Pi_3 + \Pi_1\Pi_2)X_{t-1} \\ & + \Pi_1(\Pi_3 + \Pi_1\Pi_2)X_{t-2} \\ & + \ldots\ldots\ldots \\ & + \Pi_1^{s-1}(\Pi_3 + \Pi_1\Pi_2)X_{t-s} + \Pi_1^{s}\Pi_3 X_{t-s} \end{aligned} \qquad (5.10)$$

and if Π_1^s converges to a zero matrix when s increases indefinitely[2], we have:

$$Y_t = \Pi_2 X_t + \sum_{r=1}^{\infty} \Pi_1^{r-1}(\Pi_3 + \Pi_1\Pi_2)X_{t-r} \qquad (5.11)$$

This is known as the final form of the model which describes the current endogenous variables in terms of current and lagged exogenous variables. Its successive coefficient matrices are

$$\Pi_2,\ (\Pi_1\Pi_2 + \Pi_3),\ \Pi_1(\Pi_1\Pi_2 + \Pi_3),\ \Pi_1^2(\Pi_1\Pi_2 + \Pi_3), \ldots.$$

which measure the dynamic responses of the endogenous variables and their elements are known as the interim multipliers.

Finally the total effect of the exogenous changes from the beginning until the very end will be given by the infinite sum:

$$M = \Pi_2 + (\Pi_1\Pi_2 + \Pi_3) + \Pi_1(\Pi_1\Pi_2 + \Pi_3) + \Pi_1^2(\Pi_1\Pi_2 + \Pi_3) + \ldots.$$

$$= \Pi_2 + (I_{19} + \Pi_1 + \Pi_1^2 + \ldots.)(\Pi_1\Pi_2 + \Pi_3)$$

$$= \Pi_2 + (I_{19} - \Pi_1)^{-1}(\Pi_1\Pi_2 + \Pi_3)$$

where I_{19} is an identity matrix of order 19.

The $(i,j)^{th}$ elements of M are then called the total multiplier of the j^{th} exogenous variable with respect to the i^{th} endogenous variable which measures the cumulative effect of a unit increase in the j^{th} exogenous variable on the i^{th} endogenous variable, keeping all other exogenous variables constant.

5.2 Multipliers and Policy Analysis

The reduced and final form obtained in the preceeding section enable us to explore more in detail the functioning of the economy. Suppose the government increases its consumption expenditure which is financed by taxpayers, that is, the tax revenue of the government is also increased by the same amount. What will then be the effect of this policy to the economy at large? This can be answered by the impact, interim and total multipliers obtained in the reduced and final form of the present model. Tables 5.1 to 5.3 show respectively the gross and net effects of a million dollar (in constant 1973 market prices) increase in both government consumption expenditure and tax revenue.

From Table 5.1 we see that one million dollar increase in the government consumption expenditure induces instantaneously 0.1257 million dollar increase private consumption expenditure, 0.6393 million dollar increment in imports of merchandises, 0.0511 million dollar increase in

TABLE 5.1 CHANGES IN SELECTED VARIABLES FOR UNIT INCREASE (ONE MILLION DOLLAR IN 1973 MARKET PRICES) IN GOVERNMENT CONSUMPTION EXPENDITURE

Lag in Quarters	CP	IPV	DEG	MG	ES	MS	GDP	PC	P
0	0.1257	0.0000	-0.000028	0.6393	0.0511	0.0138	0.5236	0.000160	0.000333
1	0.0708	0.0610	-0.000049	0.0660	0.0053	0.0170	0.0541	0.000183	0.000233
2	0.0323	0.0433	-0.000061	0.0362	0.0026	0.0122	0.0297	0.000177	0.000198
3	0.0251	0.0301	-0.000065	0.0261	0.0017	0.0092	0.0215	0.000159	0.000166
4	0.0202	0.0210	-0.000064	0.0192	0.0011	0.0072	0.0158	0.000138	0.000139
5	0.0164	0.0146	-0.000059	0.0143	0.0008	0.0057	0.0117	0.000117	0.000115
6	0.0134	0.0102	-0.000053	0.0106	0.0005	0.0046	0.0088	0.000098	0.000095
7	0.0109	0.0072	-0.000047	0.0080	0.0004	0.0038	0.0066	0.000082	0.000079
8	0.0089	0.0051	-0.000040	0.0061	0.0002	0.0031	0.0050	0.000068	0.000066
9	0.0072	0.0036	-0.000035	0.0046	0.0002	0.0025	0.0038	0.000057	0.000055
10	0.0059	0.0026	-0.000029	0.0035	0.0001	0.0021	0.0029	0.000048	0.000046
11	0.0048	0.0018	-0.000025	0.0027	0.0001	0.0017	0.0022	0.000040	0.000039
Sub-Total	0.3416	0.2005	-0.000555	0.8366	0.0641	0.0829	0.6857	0.001327	0.001564
Total	0.3595	0.2045	-0.000751	0.8439	0.0628	0.0902	0.6918	0.001683	0.001934

exports of services, 0.0138 million dollar increase in imports of services, negligible decrease in domestic exports of goods and no change in the gross domestic fixed private capital formation. These jointly give an increment of 0.5236 million dollar in gross domestic product; 1 + 0.1257 - 0.6393 + 0.0511 - 0.0138 = 0.5237 which differs from 0.5236 due to rounding errors. This increase in the gross domestic product, which is even less than the original increase in government consumption expenditure, seems odd at first glance. Even the total multiplier of gross domestic product with respect to the government consumption expenditure is 0.6918 which is also smaller than unity. However if one is reminded the high marginal propensity to import inherited by this small open economy, which is 1.22 estimated by the quarterly model, the result is what can be expected. On the one hand some of the government expenditure is on imported goods and services and some go to people as their incomes. Upon receiving the money, people will spend as consumers in the form of private consumption expenditure, or as producers in the form of capital formation. Both these are of imported-contents which will be a leakage to the economy. This erodes the increase in the gross domestic product and consequently the multipliers of gross domestic product with respect to government consumption expenditure are less than unity in both short and long run.

The expansionary policy of government has negligible effects on the price level of the economy; the impact multipliers of the consumer price index and gross domestic product deflator with respect to the teh government consumption expenditure are 0.00016 and 0.00033 respectively which are relatively small. Their interim multipliers diminish gradually in magnitudes and the total multipliers for 12 quarters are 0.00133 and 0.00156 respectively. If we define the dynamic elasticity as the product of the 'sub-total' multiplier and the ratio between the sample means of the variables involved, then the dynamic elasticity of consumer price

index and gross domestic product deflator are 0.00743 and 0.00802 respectively for a period of 12 quarters. These dynamic elasticities could tell how the rate of change of the consumer price index and gross domestic product deflator respond to the rate of change of government consumption expenditure over time. Thus a one per cent increase in government consumption expenditure will contribute to the inflation rate by approximately 0.008 per cent only after a time interval of 12 quarters has elapsed.

The above analyzes the impacts of the increase in government consumption expenditure. The opposite will result from a million dollar increase in the tax revenue where the instant and dynamic responses are shown in Table 5.2. With the exception of the immediate response of the private consumption expenditure, which is reduced by 0.2702 million dollar, the magnitudes of changes in other endogenous variables are all smaller than those in the case of the same amount increase in government consumption expenditure. The total multiplier of gross domestic product with respect to the tax revenue is -0.1660 which is small in magnitude and is about one-quarter of 0.6918, the total multiplier of gross domestic product with respect to government consumption expenditure. The dynamic elasticities of consumer price index and gross domestic product deflator for a period of 12 quarters with respect to taxation are 0.00303 and 0.00328 respectively. This shows that a one per cent increase in the tax revenue of government can, on the average, curb the inflation rate by 0.003 per cent within a period of 12 quarters.

The effects on endogenous variables for a million dollar increase in government consumption expenditure accompanied by the same amount increase in taxes have been presented in Tables 5.1 and 5.2. The net effect of such a policy can be obtained by simply adding the corresponding

TABLE 5.2 CHANGES IN SELECTED VARIABLES FOR UNIT INCREASE (ONE MILLION DOLLAR IN 1973 MARKET PRICES) IN TAXATION REVENUE OF HONG KONG GOVERNMENT

Lag in Quarters	CP	IPV	DEG	MG	ES	MS	GDP	PC	P
0	-0.2702	0.0000	0.0000067	-0.1534	-0.1203	-0.0033	-0.1257	-0.000038	-0.000080
1	-0.0170	-0.0146	0.0000117	-0.0158	-0.0013	-0.0041	-0.0130	-0.000044	-0.000056
2	-0.0077	-0.0104	0.0000146	-0.0087	-0.0006	-0.0029	-0.0071	-0.000043	-0.000047
3	-0.0060	-0.0060	0.0000155	-0.0063	-0.0004	-0.0022	-0.0052	-0.000038	-0.000040
4	-0.0048	-0.0050	0.0000152	-0.0046	-0.0003	-0.0017	-0.0038	-0.000033	-0.000033
5	-0.0039	-0.0035	0.0000142	-0.0034	-0.0002	-0.0014	-0.0028	-0.000028	-0.000028
6	-0.0032	-0.0025	0.0000128	-0.0026	-0.0001	-0.0011	-0.0021	-0.000024	-0.000023
7	-0.0026	-0.0017	0.0000112	-0.0019	-0.0001	-0.0009	-0.0016	-0.000020	-0.000019
8	-0.0021	-0.0012	0.0000097	-0.0015	-0.0001	-0.0007	-0.0012	-0.000016	-0.000016
9	-0.0017	-0.0009	0.0000082	-0.0011	-0.0000	-0.0006	-0.0009	-0.000014	-0.000013
10	-0.0014	-0.0006	0.0000071	-0.0008	-0.0000	-0.0005	-0.0007	-0.000011	-0.000011
11	-0.0012	-0.0004	0.0000060	-0.0007	-0.0000	-0.0004	-0.0005	-0.000010	-0.000009
Sub-Total	-0.3218	-0.0468	0.0001330	-0.2008	-0.0154	-0.0198	-0.1646	-0.000319	-0.000375
Total	-0.3262	-0.0491	0.0001803	-0.2025	-0.0151	-0.0216	-0.1660	-0.000404	-0.000464

coefficients of these two tables, and is indicated in Table 5.3. There we see that the impact multiplier of a balanced budget policy is 0.3979 and the interim multipliers diminish to 0.0017 within three years. The simple unity balanced budget multiplier does not hold in this small open economy! Even the total multiplier, which is estimated to be 0.5258, is much smaller than unity.

One interesting point to be noted in this balanced budget policy analysis is that the immediate effect on private consumption expenditure is negative (of magnitude 0.1445) but the latter impacts are positive. Though the magnitudes are small for each individual quarter, the interim multipliers ass up to a figure larger than the impact multiplier. The cumulative effect of the balanced budget policy on private consumption expenditure will become positive on the ninth quarter after the administration of the policy.

In the preceeding discussion, attention has been paid to the government's fiscal policy as an initiator of changes in the economy. There can be other changes affect the performance of the economy. Being a small open economy, Hong Kong is inevitably influenced by external forces such as recession of its main markets or an extraordinary increase in its imports prices. The impact of the latter on the price level of the economy has been discussed in section 3.4 of chapter III. However its impact on the components of the gross domestic product had not been investigated. In Table 5.4 and 5.5 we show the multipliers of selected variables correspond to changes in the gross national product of the United States as well as to changes in the unit value index of imports respectively.

The impacts of foreign disturbances to this trade-oriented small economy are significant. In Table 5.4, the 12-quarter cumulative

TABLE 5.3 CHANGES IN SELECTED VARIABLES FOR A SIMULTANEOUS UNIT INCREASE (ONE MILLION DOLLAR IN 1973 MARKET PRICES) IN GOVERNMENT CONSUMPTION EXPENDITURE AND TAXATION REVENUE

Lag in Quarters	CP	IPV	DEG	MG	ES	MS	GDP	PC	P
0	-0.1445	0.0000	-0.000021	0.4859	0.0388	0.0105	0.3979	0.000122	0.000253
1	0.0538	0.0464	-0.000047	0.0502	0.0040	0.0129	0.0411	0.000139	0.000177
2	0.0246	0.0329	-0.000046	0.0275	0.0020	0.0093	0.0226	0.000134	0.000151
3	0.0191	0.0241	-0.000050	0.0198	0.0013	0.0070	0.0163	0.000121	0.000126
4	0.0154	0.0160	-0.000049	0.0146	0.0008	0.0055	0.0120	0.000105	0.000106
5	0.0125	0.0111	-0.000045	0.0109	0.0006	0.0043	0.0089	0.000089	0.000087
6	0.0102	0.0077	-0.000040	0.0080	0.0004	0.0035	0.0067	0.000074	0.000072
7	0.0083	0.0055	-0.000036	0.0061	0.0003	0.0029	0.0050	0.000062	0.000060
8	0.0068	0.0039	-0.000030	0.0046	0.0001	0.0024	0.0038	0.000052	0.000050
9	0.0055	0.0027	-0.000027	0.0035	0.0001	0.0019	0.0029	0.000043	0.000042
10	0.0045	0.0020	-0.000022	0.0027	0.0001	0.0016	0.0022	0.000037	0.000035
11	0.0036	0.0014	-0.000019	0.0020	0.0001	0.0013	0.0017	0.000030	0.000030
Sub-Total	0.0198	0.1537	-0.000432	0.6358	0.0486	0.0631	0.5211	0.001008	0.001189
Total	0.0333	0.1554	-0.000571	0.6414	0.0477	0.0686	0.5258	0.001279	0.001470

TABLE 5.4 CHANGES OF SELECTED VARIABLES FOR UNIT INCREASE (ONE BILLION US DOLLAR IN 1973 MARKET PRICES) OF GROSS NATIONAL PRODUCT OF UNITED STATES

Lag in Quarters	CP	IPV	DEG	MG	ES	MS	GDP
0	0.6648	0.0000	4.9899	3.3820	0.6783	0.1810	2.7700
1	0.7747	0.3227	3.0436	2.3861	0.4435	0.2441	1.9543
2	0.6382	0.4233	1.8563	1.6335	0.2848	0.2309	1.3381
3	0.5184	0.4147	1.1320	1.1277	0.1828	0.1961	0.9241
4	0.4207	0.3615	0.6902	0.7857	0.1174	0.1599	0.6442
5	0.3415	0.2961	0.4207	0.5523	0.0757	0.1286	0.4531
6	0.2775	0.2334	0.2563	0.3916	0.0489	0.1031	0.3215
7	0.2258	0.1794	0.1561	0.2801	0.0317	0.0828	0.2302
8	0.1838	0.1356	0.0950	0.2021	0.0206	0.0666	0.1662
9	0.1497	0.1012	0.0578	0.1471	0.0134	0.0539	0.1211
10	0.1219	0.0749	0.0351	0.1080	0.0088	0.0436	0.0890
11	0.0992	0.0551	0.0213	0.0799	0.0057	0.0354	0.0659
Sub-Total	4.4162	2.5979	12.7543	11.0761	1.9116	1.5260	9.0767
Total	4.8103	2.7371	12.7848	11.2968	1.9023	1.6768	9.2608

TABLE 5.5 CHANGES OF SELECTED VARIABLES FOR UNIT INCREASE OF UNIT VALUE INDEX OF IMPORTS OF GOODS

Lag in Quarters	CP	IPV	DEG	MG	ES	MS	GDP
0	1.0919	0.0000	-2.5806	-8.2854	-2.5147	-0.2676	4.5496
1	-7.0297	4.4821	-1.5966	4.1453	-0.7427	-0.5109	-8.5214
2	-4.8778	-1.6519	-0.9865	-4.3237	-0.9985	-0.7932	-3.3978
3	-2.4434	-1.6486	-0.6090	-2.6242	-0.5972	-0.6026	-2.0696
4	-1.2482	-1.4000	-0.3756	-1.6769	-0.3618	-0.3799	-1.3289
5	-0.6201	-1.1059	-0.2315	-1.0933	-0.2209	-0.2147	-0.8704
6	-0.2916	-0.8377	-0.1427	-0.7216	-0.1362	-0.1099	-0.5768
7	-0.1228	-0.6179	-0.0879	-0.4797	-0.0849	-0.0491	-0.3848
8	-0.0386	-0.4475	-0.0542	-0.3202	-0.0536	-0.0162	-0.2576
9	0.0011	-0.3200	-0.0334	-0.2142	-0.0344	0.0002	-0.1727
10	0.0179	-0.2266	-0.0206	-0.1435	-0.0225	0.0075	-0.1159
11	0.0232	-0.1593	-0.0128	-0.0962	-0.0151	0.0100	-0.0778
Sub-Total	-15.5381	-3.9315	-6.7314	-15.8336	-5.7825	-2.9264	-13.2241
Total	-15.5034	-4.3324	-6.7559	-16.1279	-5.8739	-2.8757	-13.4620

multiplier of the economy's gross domestic product with respect to the gross national product of the United States is 9.2608, or a dynamic elasticity of 1.1119. Moreover the effect of these exogenous change on the domestic exports of goods is larger than that on the imports of merchandises; the impact and 12-quarter total multipliers of domestic exports of goods with respect to the unit increase in gross national product of the United States are respectively 4.9899 amd 12.7543, while of the imports of merchandises are 3.3820 and 11.0761. Thus the visible trade gap, which is the difference between the exports and imports of merchandises, will become smaller whenever the United States economy recovers, or grows over time.

The external disturbance to the economy can also be in the form of an abrupt increase in the imports prices like that experienced during the 1973-74 oil crisis period. The 12-quarter total multiplier of gross domestic product with respect to the unit value index of imports is -13.2241, or a dynamic elasticity of -0.1644. This means that whenever there is one per cent increase in the price of imports, the gross domestic product of the economy will be decreased by 0.17 per cent within 12 quarters The oil crisis in 1973 to 1974 resulted in sharp increase in the price of imports which led the economy into recession in these two years.

In the above multiplier and policy analysis, it is noted that the variables we have chosen for investigation are considered the most interest ones at the present time when the introduction of economic policies in fighting inflation and maintaining high economic growth is of concern. With elapses of time, other variables may deserve our focus. The following section will be an illustration.

5.3 The Re-Emergence of the Entrepot Trade

Hong Kong has its golden age of the entrepot trading at the decade of 1930s. As James Reidel (1971) has pointed out, this economic activity was the source of the economy's growth over the first one hundred years of time since its ceding to the Great Britain under the Treaty of Naking and the Convention of Peking in 1842 and 1860 respectively. It also served as the cornerstone of the economy's post-war growth with the development of banking, insurance, warehouse services and port facilities in the said period. The Civil War between the Nationalist and the Communist China in the 1940s and the imposition of the Embargo on trade with the later by the United States resulted a severe drop in the re-exports during the double decades of fifties and sixities. Thus re-exports did not seem to be an interesting variable to be investigated with the multiplier analysis. However the reconciliation between People's of Republic of China and Western countries has given new life to this old form of trading of the colony in the late seventies. Table 5.6 shows the growth of re-exports in the estimation period, 1974 to 1980.

The double digit growth in re-exports in 1976 was attributed to the recovery from the recession due to oil crisis. However the continuous double digit growth between 1978 and 1980 was due to the modernisation policy of the People's Republic of China which results in its openness of foreign trade with the Western nations.

The resurrection of the entrepot trading in the late seventies is thus of benefits to the economy. Its contribution to the gross domestic product of the economy cannot be solely treated as a component of the latter since there are other side effects as explained earlier in the discussion of multiplier analysis. One way to evaluate this is to compare the two simulated paths of the gross domestic product, one obtained in

TABLE 5.6

RE-EXPORTS OF HONG KONG
(1974-1980)

Year	Re-Exports in 1973 Prices	Growth Rate
1974	5,789($mn.)	
1975	5,889	1.73(%)
1976	6,929	17.67
1977	7,425	7.16
1978	9,484	27.73
1979	12,172	28.34
1980	16,530	35.80

Source: Census and Statistics Department, Hong Kong External Trade, Hong Kong: Government Printer, various issues.

section 4.2 of chapter IV and the other by the assumption that there is no growth in re-exports from 1978 onwards. The two time paths are represented by path A and path B respectively in figure 5.1. There we see that the gap between the two paths diverge over time, which suggests re-exports grow rapidly in this time period. The gross domestic product would have increased by 2,248 million dollars (in 1973 market prices) if there was no growth in re-exports since 1978. In fact there are 2,721 million dollars increase in gross domeztic product with the presence of drastic growth in re-exports. Thus the growth of re-exports since 1978 contributes to the growth of gross domestic product by 17.38 per cent, that is, nearly one-fifth of the double digit growth rate of the gross domestic product in the three years 1978 to 1980 is attributed to the resurrection of the entrepot trading. Thus the above analysis would allow us to shift our focus under different economic situations.

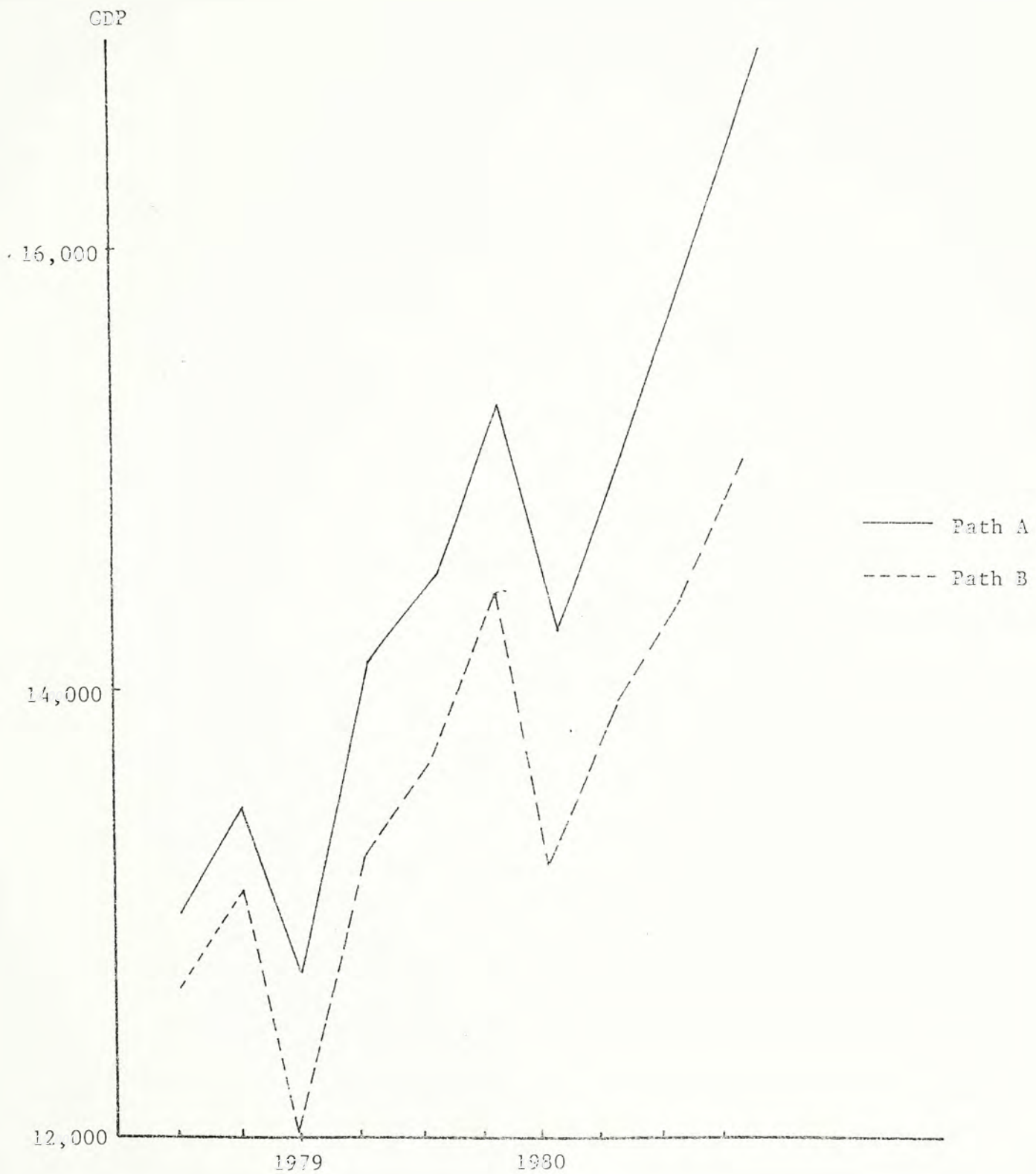

Figure 5.1 Contribution of Re-Exports to GDP

FOOTNOTES FOR CHAPTER V

1. An identity is added for the lagged value of gross domestic product deflator (P_{-1}) since there is lagged two quarters value (P_{-2}) entering as explanatory variable in the model. The addition of this identity enables us to calculate the reduced form of the present model as suggested in equation (5.7) where P_{-1} appears in both sides of the identity. Thus the order of Y is 19 x 1 but not 18 x 1. The same applies to the order of matrices concerned.

2. The necessary and sufficient condition for the convergence to a zero matrix of Π_1^s when s increases indefinitely is that all eigenvalues of Π_1 be of magnitudes smaller than unity. In the quarterly model all of these values are real and less than one in absolute value. They are: 'ten' zeros, 0.9618, 0.8256, 0.6855, 0.6366, 0.6103, 0.5384, 0.4079, 0.0270 and 0.0017. The fulfillment of the condition of convergence also guarantees that the system is stable with respect to the exogenous changes. The proof can be obtained in H. Theil and J.C.G. Boot, 'The Final Form of Econometric Equation Systems,' Review of the International Statistical Institute, Vol. 30, 1962, pp. 136-52.

CHAPTER VI

CONCLUDING REMARKS

6.1 Summary of Main Findings

In the preceeding chapters, a quarterly macroeconometric model has been built for the Hong Kong economy. We have used this model for the three principal purposes of econometrics: structural analysis, forecasting and policy evaluation. It seems appropriate here to summarise the main findings of this study.

Firstly, as detailed in section 3.3 of chapter III, we found that the import leakage of the Hong Kong economy is great, with an estimated marginal propensity to import being 1.22, or an income elasticity 1.42. This results in a less powerful fiscal policy in stimulating the economy; the impact and total multipliers of gross domestic product with respect to the government consumption expenditure are approximately 0.5 and 0.7 respectively.

Secondly the simple unity balanced budget multiplier does not seem to hold in the colony. Instead the balanced budget multipliers for the immediate and long run are estimated approximately to be 0.4 and 0.5 respectively, which suggest the existence of 'crowding out' effect.

Thirdly the present study appears to be a haven for the rapid growing government size. The latter is attacked as a major factor in pulling up the price level of the economy. In this study

it has been found that the 12-quarter dynamic elasticity of consumer price index (A) with respect to the government consumption expenditure is about 0.008 which suggests that whenever the government increases its consumption expenses by one per cent, the consumer price index (A) will be pulled up by only 0.008 per cent after 12 quarters have elapsed. This marginal contribution is certainly of negligible content compared with the double digit inflation rate.

Fourthly, through merchandises transactions we observe that the extent to which the Hong Kong economy depends on external trade is both wide and deep. The trading activities provide basic channels through which disturbances originating in other countries get transmitted to Hong Kong. The extraordinary increase in import prices during the period of 1973 to 1975, accompanied by the serious recessions in the major markets of the colony's domestic exports, resulted in a recession of the economy in the said period.

The fact that this small open economy is heavily affected by external disturbances is once again affirmed through the structural analysis of the quarterly model. We have found that changes on the price level of the economy are more sensitive to changes on import prices than to the changes on money supply.

Another interesting feature found in the study is the emerging role of the re-exports. Hong Kong had its golden age in the entrepot trading in the 1930s. However political arrangements led to a drastic decrease in these activities during the 1950s and 1960s. The modernisation policy of the People's Republic of China leads to the resurrection of this entrepot trading activities.

The tremendous growth of re-exports in real terms since 1978 has contributed about 29 per cent to the double digit growth rate in the gross domestic product in the three years 1978 to 1980.

Finally the system is stable in responding to changes in exogenous variables. This is because the eigenvalues of the matrix Π_1 in equation (5.8) of section 5.1 of chpater V are all with magnitudes less than unity. The dynamic responses will be diminished in magnitudes with elapsing of time. Furthermore all these eigenvalues found are real which suggest that there is no cyclical movement of the system.

The forecasts made for the quarters in 1982 are based on two different views towards the recovery time of the United States. If the recovey starts at the second half of the year 1982 as the optimists have expected, there would be a large increase in the exports of goods of the Hong Kong economy and thus a continuation of double-digit growth rate of the gross domestic product; otherwise the growth rate of domestic exports of goods would be lowered and stand at 2 per cent level while the growth rate of gross domestic product would be 6 per cent by the end of 1982.

6.2 Final Remarks

Having summarised the main findings of the study, it is relevant to consider possible extensions of the present model.

Firstly, from a structural point of view, improvement should envisage at the possibility of introducing two more sectors: the labor sector and the manufacturing sector. It is assumed in the quarterly model that wage of manufacturing workers is exogenous;

introduction of the labor and manufacturing sectors can explain the variations in wage of manufacturing workers. However the most important reason for their introductions lies on the fact that manufacturing goods represent more than 90 per cent of total domestic exports of goods and hence can improve the explanatory power of the model, especially the trade sector, through the improvement in the explanation of the domestic exports of goods which deviates most in historical simulation performed in section 4.1 of chapter IV.

Secondly, the variables in the model are highly aggregated. Whenever possible they should be replaced by more disaggregated ones. For instance, private consumption expenditure may be separated into durable and non-durable consumer goods. The finer the variables are defined, the better will the resultant model be in the explanation of these disaggregated items.

Finally the Box-Jenkins univariate time-series models have recently emerged as valid contenders of the econometric models[1] since they are stochastic and the information exploited by the time-series model are covered by the information set exploited by the econometric models. Briefly speaking, the time-series models try to infer the future behaviour of a variable by investigating solely the past trends of this variable; thus are useful when little is known about the underlying process of that variable. Moreover they can only serve short term forecasting purpose by their limited structures. Consequently the saying that time-series models can be substitutes for the econometric models is undoubtedly wrong. Instead the short term forecasting ability of a time-series model makes it possible to be in complementary usage with the

econometric models. For instance in assigning future values to the exogenous variables, we can use the method of time series analysis to predict these future values of exogenous variables. In fact extrapolation, which had been used to assign future values of some exogenous variables in the present model, is an example of this technique. More sophisticated time-series models have to be built on the prediction of future values of exogenous variables so that, accompanying with the quarterly model, quality of the forecasts can be improved.

FOOTNOTES FOR CHAPTER VI

1. The details of the Box-Jenkins technique can be obtained from G,E,P, Box & G.M. Jenkins, Time Series Analysis: Forecasing and Control, San Francisco, Holden-Day Inc., 1970. As for the application in macroeconomics, see O.D. Anderson (ed.), Analysing Time Series, North-Holland Publishing Co., Amsterdam, 1980.

APPENDIX

REDUCED FORM OF THE QUARTERLY MODEL

Endo-genous Variable	Pre-determined Variable			
	C0	D1	D2	D3
CP	0.125674	-661.212000	-815.018000	-872.750000
C	1.125674	-661.212000	-815.018000	-872.750000
IPV	0	0	0	0
CF	0	0	0	0
DEG	-0.000028	-671.991000	585.399000	647.571000
EG	-0.000028	-671.991000	585.399000	647.571000
MG	0.639324	-923.365000	- 20.447400	-592.634000
ES	0.051127	-126.333000	45.943900	4.397700
MS	0.013809	1.796200	4.947900	9.726700
GDP	0.523641	-537.967000	-168.076000	362.125000
PE	0.000008	-0.008193	- 0.002600	0.005500
PC	0.000160	-0.163967	- 0.051200	0.110300
P	0.000333	-0.341964	- 0.106800	0.230200
SDEP	0.276030	-283.582000	- 88.598900	190.989000
TDEP	0.259555	-266.657000	- 83.310900	179.496000
DDEP	0.287272	-295.131000	- 92.207200	198.664000
CURR	0.016631	- 17.086300	- 5.338200	11.501400
M2	0.839488	-862.456000	-269.455000	580.551000

Appendix (continued)

Endo-genous Variable	Pre-determined Variable ER	IG	IS	PM
CP	-2.027700	0.125674	0.125674	1.091900
C	-2.027700	0.125674	0.125674	1.091900
IPV	0	0	0	0
CF	0	1.000000	0	0
DEG	-15.219600	- 0.000028	-0.000028	-2.580600
EG	-15.219600	- 0.000028	-0.000028	-2.580600
MG	-10.315300	0.639324	0.639324	-8.285350
ES	- 2.068886	0.051127	0.051127	-2.514680
MS	- 0.552074	0.013809	0.013809	-0.267613
GDP	- 8.448770	0.523641	0.523641	4.549590
PE	- 0.000129	0.000008	0.000008	0.741550
PC	0.002574	0.000160	0.000160	0.231001
P	- 0.005371	0.000333	0.000333	0.389975
SDEP	- 4.453650	0.276030	0.276030	18.922800
TDEP	- 4.187840	0.259555	0.259555	17.869400
DDEP	- 4.635030	0.287272	0.287272	19.914600
CURR	- 0.268339	0.016631	0.016631	1.216720
M2	-13.544900	0.839488	0.839488	57.943600

Appendix (continued)

Endo-genous Variable	Pre-determined Variable			
	PWE	REG	R90	TAX
CP	0.359711	0.132226	-0.023629	-0.270162
C	0.359711	0.132226	-0.023629	-0.270162
IPV	0	0	0	0
CF	0	0	0	0
DEG	2.699920	-0.000029	-0.003291	0.000007
EG	2.699920	1.000000	-0.003291	0.000007
MG	1.829910	0.677745	-0.062944	-0.153438
ES	0.367012	0.135930	-0.138575	-0.012271
MS	0.097937	0.036273	-0.004096	-0.003314
GDP	1.498800	0.555110	-0.098454	-0.125674
PE	0.000023	0.000008	0.000946	-0.000002
PC	0.000457	0.000169	0.018912	-0.000038
P	0.000953	0.000353	0.039465	-0.000080
SDEP	0.790070	0.292618	2.465550	-0.066247
TDEP	0.742915	0.275154	169.908000	-0.062293
DDEP	0.822246	0.304536	-72.945300	-0.068945
CURR	0.047603	0.017631	0.106366	-0.003992
M2	2.402830	0.889938	99.534400	-0.201477

Appendix (continued)

Endogenous Variable	Pre-determined Variable			
	TOUR	USAGNP	WMF	$CURR_{-1}$
CP	0.310861	0.664799	-0.988681	-0.000240
C	0.310861	0.664799	-0.988681	-0.000240
IPV	0	0	0	0
CF	0	0	0	0
DEB	-0.000069	4.989850	-0.452182	-0.000033
EG	-0.000069	4.989850	-0.452182	-0.000033
MG	1.581400	3.381950	2.830210	-0.000639
ES	2.650500	0.678293	0.203194	-0.001407
MS	0.084637	0.181002	0.051625	-0.000042
GDP	1.295260	2.770000	-4.119500	-0.001000
PE	0.000020	0.000042	0.129937	0.000010
PC	0.000395	0.000844	-0.001255	0.000192
P	0.000823	0.001761	-0.002619	0.000401
SDEP	0.682776	1.460170	-2.171540	0.016612
TDEP	0.642025	1.373020	-2.041930	0.015720
DDEP	0.710583	1.519630	-2.259980	0.017518
CURR	0.041138	0.087977	-0.130839	0.961080
M2	2.076520	4.440790	-6.604290	1.010930

Appendix (continued)

Endogenous Variable	Pre-determined Variable			
	IPV_{-1}	MS_{-1}	$SDEP_{-1}$	P_{-1}
CP	0.079175	-0.047480	0.132765	1.283130
C	0.079175	-0.047480	0.132765	1.283130
IPV	0.630000	0	0	10.210000
CF	0.630000	0	0	10.210000
DEG	-0.000017	0.000010	-0.000003	- 0.000283
EG	-0.000017	0.000010	-0.000003	- 0.000283
MG	0.402774	-0.241539	0.064937	6.527500
ES	0.032210	0.013537	0.006796	0.522007
MS	0.008699	0.405440	0.021435	0.140984
GDP	0.329894	-0.197834	0.053187	5.346470
PE	0.000005	-0.000003	0.000001	0.000081
PC	0.000101	-0.000060	0.000016	0.001627
P	0.000210	-0.000126	0.000034	0.003398
SDEP	0.173899	-0.104285	0.028037	2.818270
TDEP	0.163520	-0.098061	0.026363	2.650060
DDEP	0.180981	-0.108533	0.029178	2.933040
CURR	0.010478	-0.006283	0.001689	0.169805
M2	0.528878	-0.317162	0.085276	8.571180

Appendix (continued)

Endogenous Variable	Pre-determined Variable			
	$TDEP_{-1}$	$DDEP_{-1}$	P_{-2}	DEO_{-1}
CP	0.132572	-0.000160	-1.312030	0.081268
C	0.132572	-0.000160	-1.312030	0.081268
IPV	0	0	-10.440000	0
CF	0	0	-10.440000	0
DEG	-0.000030	-0.000022	0.000290	0.609982
EG	-0.000030	-0.000022	0.000290	0.609982
MG	0.064424	-0.000426	- 6.674540	0.413424
ES	0.005667	-0.000938	- 0.533767	0.082918
MS	0.021401	-0.000028	- 0.144160	0.022127
GDP	0.052384	-0.000667	- 5.466810	0.338617
PE	0.000009	0.000006	- 0.000083	0.000005
PC	0.000170	0.000128	- 0.001665	0.000103
P	0.000355	0.000267	- 0.003475	0.000215
SDEP	0.041360	0.011074	- 2.981750	0.178497
TDEP	0.808972	0.010480	- 2.709760	0.167844
DDEP	0.043229	0.651678	- 2.999120	0.185767
CURR	0.002556	0.000720	- 0.173630	0.010755
M2	0.896117	0.673953	- 8.764260	0.542862

Appendix (continued)

Endogenous Variable	Pre-determined Variable				
	PC_{-1}	PE_{-1}	GDP_{-1}	$HSBPR_{-1}$	PM_{-1}
CP	-45.960400	7.295170	0.013824	-0.412210	- 7.081370
C	-45.960400	7.295170	0.013824	-0.412210	- 7.081370
IPV	0	0	0.110000	-3.280000	0
CF	0	0	0.110000	-3.280000	0
DEG	- 0.093673	- 0.001611	-0.000003	0.000091	0.001564
EG	- 0.093673	- 0.001611	-0.000003	0.000091	0.001564
MG	-24.838700	-24.648200	0.070326	-2.096980	23.925900
ES	- 6.235440	- 2.079840	0.005624	-0.167697	2.018890
MS	- 5.703360	- 0.534594	0.001519	-0.045292	0.518926
GDP	-21.693500	30.396500	0.057601	-1.717540	-29.505700
PE	0.026917	0.000463	0.000001	-0.000026	- 0.000449
PC	0.538348	0.009259	0.000018	-0.000523	- 0.008988
P	0.185553	0.019322	0.000037	-0.001092	- 0.018756
SDEP	- 2.925520	16.023100	0.030363	-0.905379	-15.553500
TDEP	- 2.701490	15.066800	0.028551	-0.851341	-14.625200
DDEP	- 2.930770	16.675700	0.031600	-0.942251	-16.187000
CURR	- 0.136825	0.965418	0.001829	-0.054551	- 0.937124
M2	- 8.694610	48.731000	0.092344	-2.753520	-47.302800

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